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THE ROTARY CONVERTER.

There may be found on other pages of this issue an article by Mr. C. P. Steinmetz on "The Converter," discussing the peculiarities of this machine in the way of armature heating, field reaction, etc., features that are complicated by the internal combination of sinusoidal and square-cornered current waves in the same coils. These peculiarities have attracted considerable attention of late, as their mutual balancing effect gives the converter its advantage over the motor generator.[1] A valuable paper by Prof. Silvanus P. Thompson has been recently presented before the British Association on the same subject.[2]

As might be surmised, the discussions show that the more phases there are to the alternating current supplied to a converter the less is the heating of the armature coils. The last two tables in the part of the article by Mr. Steinmetz in this issue give the relative heating of a machine when used as a continuous-current generator and as a converter with a supply of one, two, three, four, six, twelve or as many phases as there are commutator segments. From these it will be seen that, assuming an internal energy loss of 4 per cent., and assuming unity as the power factor of the incoming current (the next to the last table), a 100-kw machine must be limited, for the same copper heating, to a rating of 82 kw if used as a single-phase converter, but may be run at 131 kw with three-phase supply, 161 with four-phase supply (commonly known as two-phase), 194 kw with six-phase supply, and 231 with as many phases as commutator segments. These figures are, of course, based on the use of commutators properly proportioned for the increased load.

The question naturally arises, can the number of phases of a given supply be readily increased without complication? In the case of three-phase rotaries this can be done. The number of phases can be exactly doubled without any change except in the rotary itself, and in the alternating-current transformers supplying it. This is due to the fact that three equal electromotive forces, differing from each other in phase by one-third of a period, if exactly reversed, give another three-phase system, which, superposed on the first, gives a six-phase combination. This reversal is readily obtained from the three single-phase transformers by a second secondary winding connected up in the reverse order from the first. This second three-phase system, displaced in phase from the first by half a period, would require, of course, three more collector rings on the rotary, and this would really be the only added complication, as most transformers are built with at least two independent secondary windings. Considering a delta-connected set of secondary windings, the corners of the delta being tapped off to the collector rings of the rotary, the added system would consist of another delta, its vectorial representation being twisted from the first, so to speak, by 60 degrees (giving a figure like this), attached to three other collector rings, the only electrical connection between the two deltas being through the armature coils of the converter. This simple change would give an immediate reduction of the heating of the armature copper on the three-phase rotary by about 50 per cent., and a consequent increase in the converting

[1] See THE ELECTRICAL WORLD, January 1, 1898, page 12, and February 12, page 216.

[2] See THE ELECTRICAL WORLD Digest, December 17, 1898, page 659.

capacity, with the same heating of the armature copper by about 50 per cent. (from 131 to 194 kw in the case assumed above). In the event of a phase displacement of the alternating system, the percentage improvement would be about the same, and there would be a further advantage in the more uniform distribution of the heating, which, as is shown by diagrams in some of the articles referred to above, piles up enormously at the coils adjacent to the collector-ring connections.

REACTIVE COILS VS. VOLTAGE-REDUCING TRANSFORMERS FOR THE STARTING OF ALTERNATING-CURRENT MOTORS.

For giving reduced voltages from alternating-current circuits for brief intervals, particularly for the starting of alternating-current motors, there are two methods coming into general use. One is the insertion of reactive coils in the incoming leads, and the other the use of voltage-reducing transformers generally of the single-coil type, with one or more taps between which and one terminal various voltages may be obtained. The latter piece of apparatus is known under several names, among them compensator, auto-converter, economy coil, etc. Their purpose in the starting of synchronous motors or induction motors with permanently short-circuited secondaries is to cut down the rush of current that would take place were the motor windings connected directly across the lines. Their analogies may be found in direct-current work, that of the reactive coil being the rheostat of the direct-current motor and that of the single-coil transformer being the Leonard system of control.

The reactive coil is somewhat the simpler of the two, especially in its wiring and manipulation. All it requires is a short-circuiting switch to cut it out when its service is no longer needed, and this may be combined with the main switch of the motor by means of a double-throw arrangement. It takes, however, as much current from the line as is demanded by the motor to give the needed starting torque, and it gives this current a considerable lag, which, while it economizes power, is injurious to voltage regulation. Its chief distinguishing peculiarity from the other method is the fact that the drop of voltage is proportional to the load, so that as the back electromotive force of the motor rises and the current falls the impressed electromotive force at the motor terminals rises also. The torque of the motor at any speed being proportional to the square of the voltage impressed upon its terminals, quite a uniform starting torque may be obtained almost to synchronism. Reactive coils are commonly not built, as are the rheostats used with direct-current motors, with many steps by which they can be gradually cut out, but are thrown out as a whole in one step, the same practice prevailing with the use of transformers, the voltage being stepped up from one starting pressure to the line pressure in one step, except in instances where a speed variation is desired.

A compensating or auto-transformer requires a trifle more complicated switching arrangement, as the terminals of its transforming coils in each phase must be connected into circuit before the motor is started and disconnected after it is up to speed by means of special switches or by means of extra blades on the motor-starting switch proper. It, however, gives to the motor a current greater than that demanded from the line in the same proportion as the voltage is reduced, and does not introduce quite such a heavy lag as does the reactive coil. When used for starting either an induction motor with a short-circuited secondary or a synchronous motor started by inductive drag, the torque is reduced as the square of the voltage delivered by the transformer, which, of course, remains practically constant no matter what the current taken by the motor may be, the voltage reduction being thus limited by the starting torque demanded.

With the induction motor, reactive coils are rarely if ever used. The speed-torque curve of the induction motor supplied from a step-down transformer is a close copy of the speed-torque curve with full line supply with all torque values reduced in proportion to the square of the voltage reduction. As the torque of such a motor with constant-potential supply generally increases as the speed rises, and holds well toward synchronism, a transformer that will give the necessary standstill torque will bring its motor up pretty close to full speed. With synchronous motors both methods are used, even by the same makers, and for the same service. As a synchronous motor approaches synchronism its demand upon the line is subject to beats or excessive fluctuations of the current similar to those of phasing lamps. Reactive coils choke these down and thereby distribute more uniformly from second to second the demand upon the line and the torque given to the motor, while voltage-reducing transformers give extreme fluctuations, varying from heavy motoring currents to almost as heavy generating currents.

THE WEAKEST LINK IN THE CHAIN.

The electric motor directly coupled or geared to its load, with no intermediate mechanism which can slip, as can a belt, becomes, especially with high-gear ratios, a source of great possible strains. Unlike the steam engine and other sources of mechanical power its maximum torque is, as a rule, a great many times that of its normal load, and, especially in the case of shunt-wound motors, any obstruction to the movement of the load tending to reduce the speed causes an instantaneous application of the great force available.

Especially is this the case with motors driving such loads as cranes, elevators, etc., where the speed reduction is considerable and worm gears are commonly used. A recent disaster that was probably in part due to this very cause is the fatal accident which occurred recently in an electrically driven elevator in New York city. Here it appears that the car came down with full speed against the bumpers and the motor continued working, lifting the counterweights after the car had struck, in spite of the greatly increased load, until the counterweights struck at the top of the shaft, throwing some of them out of the frames, whence they fell and smashed through the car with fatal results. In other instances motors have torn the cables loose from elevator drums, cars or counterweights, broken the wheel spiders or stripped the gears.

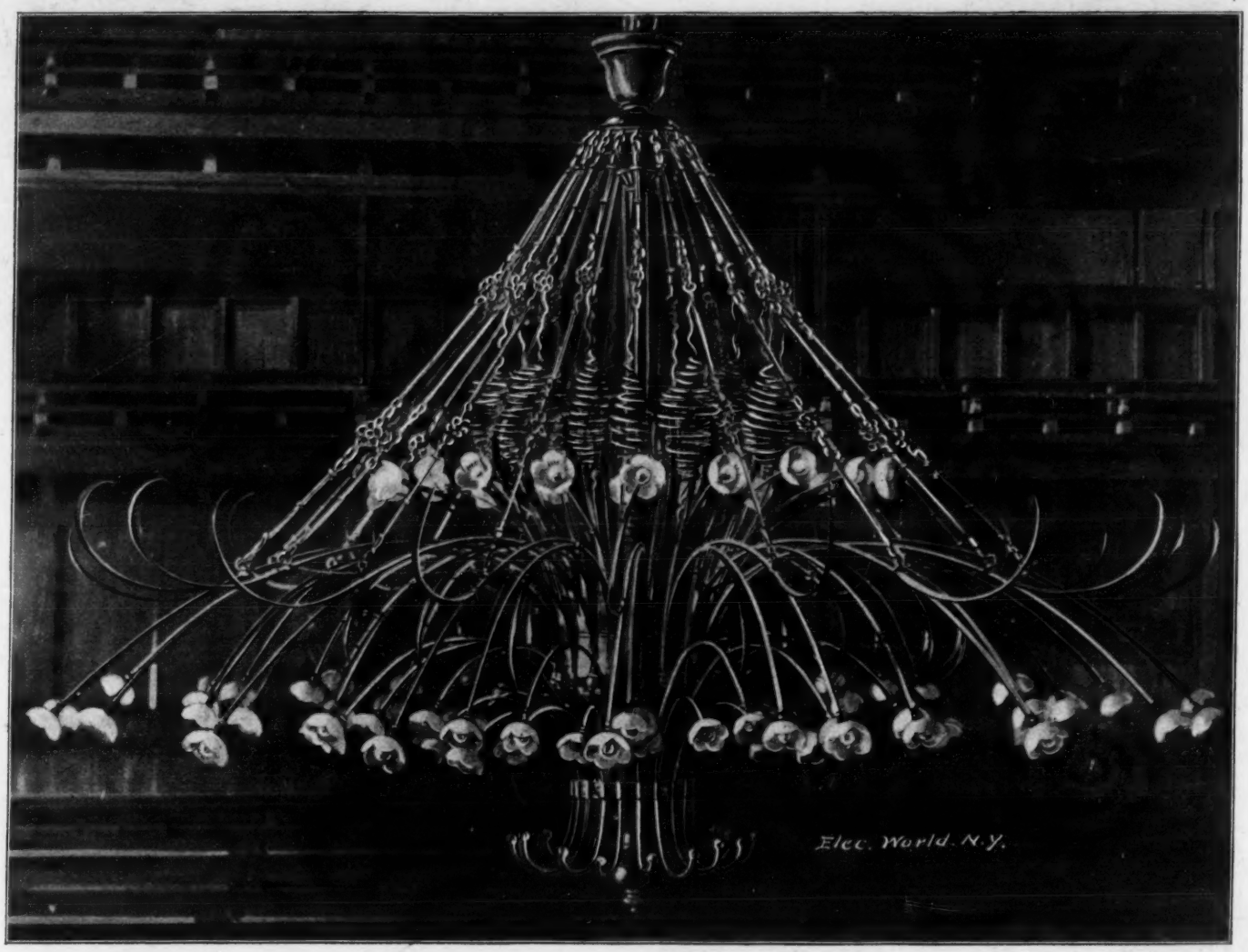
In cases of this kind the weakest point of the system will, of course, yield first to the strain, and very fortunately the weakest point can be readily made a part of the electrical circuit, the breakage of which causes no damage whatever. The action of fuses is too slow for such sudden loads as are liable to be imposed on rigidly coupled machinery, so that circuit breakers should always be installed. Unfortunately the circuit breaker, like the safety valve of early boiler installations, is very readily overweighted or tied in, and one that, like most modern types of safety valves, could not be tampered with would be a blessing for such service. With a breaker that could be absolutely depended upon the maximum strain, outside of the inertia effect of fly wheels, etc., could be exactly calculated and allowed for. In most such loads, among them cranes, elevators, etc., there is no great amount of stored kinetic energy, and where this is necessary, as in printing-press service, etc., other safeguards might be provided if necessary.

The Japanese as Manufacturers of Electrical Fixtures.

With many centuries' development of the artistic sense, the Japanese undoubtedly have a good opportunity to excel in the adaptation of the beautiful to utilitarian service. An instance of this is the design of electrical fixtures, and their progress in this line is evidenced by the accompanying illustration of the largest chandelier ever constructed in Japan.

This fixture is 22½ feet in diameter, 30 feet high, and weighs, with its 100 lamps and shades, 3240 pounds. Its design was carried out by the Tokyo Fine Arts Academy (a suggestion for Americans), and the mechanical work was carried out by the Saiga Electric Company, of Kyoto, from whom this information is derived.

The symbolism of the design is characteristic of this interesting little nation. The chandelier illuminates the interior of the newly constructed opera house in Umeta, Osaka, the commercial centre of Japan. Tradition has it that at one time the vicinity was a lagoon in which reeds flourished, and the name Umeta signifies a plum field. For these reasons the chandelier combines arms and branches shaped like the blades of reeds, with reflectors of the shape of plum blossoms, giving, as the picture indicates, a harmonious and beautiful as well as appropriate combination. The finish is in gold leaf and silver plate, lacquered. The lamps are divided between three circuits and fitted with dimming rheostats.



A JAPANESE CHANDELIER.

Measurements of the Permanent Magnetism of Bricks.

An investigation has been carried on in the electrical laboratories of the University of Rochester on the relative magnetic moments of brick made of different clays and containing different amounts of magnetite and other iron oxides. The measurements have been in charge of Prof. Henry E. Lawrence and O. A. Gage.

A Power Transmission Plant in Central New York.

The hydraulic power station and long-distance transmission lines of the Wetmore Electric Company, of Lowville, N. Y., are rapidly nearing completion. The company was organized only last summer, with a capital stock of $40,000, and work was commenced about the 23d of August. The power plant is located at Belfort, on the Beaver River, and utilizes a fall of 50 feet obtained by a head-race cut through solid rock 150 feet in length. One unit is at present under construction, with space for two more. The dynamo is a 350-kw, 60-cycle, 2200-volt, three-phase Westinghouse machine, delivering its power to raising transformers, which give the line pressure of 11,000 volts. A three-wire line of No. 5 wires carries the power to a sub-station at Lowville, and will be extended to Croghan and New Bremen.

Proposed Electric Railway in Shanghai.

Bids have been called for covering the construction of 23 miles of electric railways in the streets of Shanghai, China.

The Next New York Electrical Exhibition.

The lease of Madison Square Garden for another electrical show to be held during the month of May, 1899, has been signed by Mr. C. O. Baker, Jr., president of the Electrical Exhibition Company. The show will be under the auspices of and in connection with the twenty-second annual convention of the National Electric Light Association, which will be held in New York city during the same month. The officers of the Electrical Exhibition Company are: C. O. Baker, Jr., president; H. L. Shippy, vice-president; George F. Porter, secretary and treasurer; Marcus Nathan, general manager; H. H. Harrison, L. F. Requa, J. W. Godfrey and C. A. Lieb, directors.

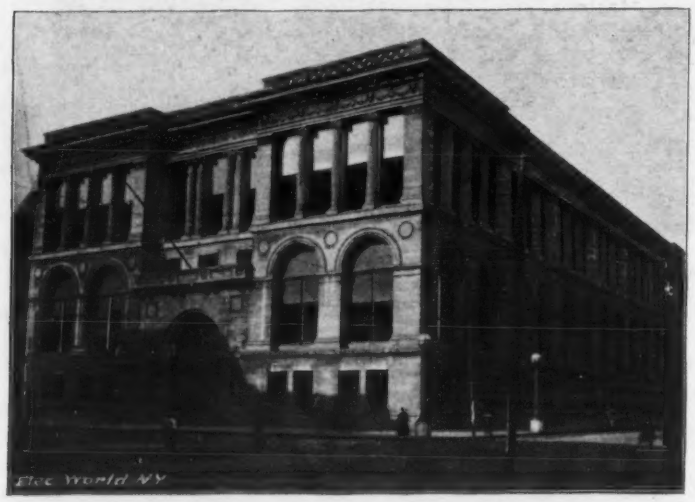
The Lighting and Power Plant of the Chicago Public Library Building.

GREAT public library buildings are not built every day. Consequently, the work of designing and installing an electric-light and power plant to meet the needs of a public library is one in which engineers have but little practice. Such a task has no hard and fast rules laid down for it, and follows no beaten path of custom. Each job of the kind is a law unto itself, the conditions to be met and the requirements to be fulfilled determining the nature of the completed work. Each such plant is interesting, when completed, as showing in what manner given necessities and conditions have been met.

Chicago has just finished building a great public library and a lighting plant for it. Starting with an even half block of space in the business centre, 352 x 146 feet, a building has been erected which is fondly boasted to be the handsomest of its kind in the world. It is of stone, without an iron frame, 90 feet high above the street level. It took five years to build, but the results accomplished seem to have more than made up for the delay. The electric plant which furnishes light and power for this palace of books is a part of the building, and is constructed on the same scale of magnificence and completeness as the rest of the structure.

As it was desirable to use practically all the space at the disposal of the public library board, and as good looks were one of the first essentials striven for, it was necessary both to make the lighting plant a part of the building and also to conceal it from view as much as possible. These ends were secured by providing a court indenting the least conspicuous side of the building, and then hiding the power-house portions at the inner side of the indentation. As the building now looks from the street, except for the presence of a couple of coal and ash hoppers and a handsome brick stack, no one would ever suspect that an 1100-hp plant was concealed inside.

This court, sacred to the uses of the power plant, is just large enough to enable teams to enter and manœuvre comfortably in front of the coal and ash hoppers. It is enclosed by a 12-foot iron fence of a most ornamental pattern, which serves to help conceal the industrial work inside. The court is entirely floored with cement, in which is embedded a scale for weighing each load of coal

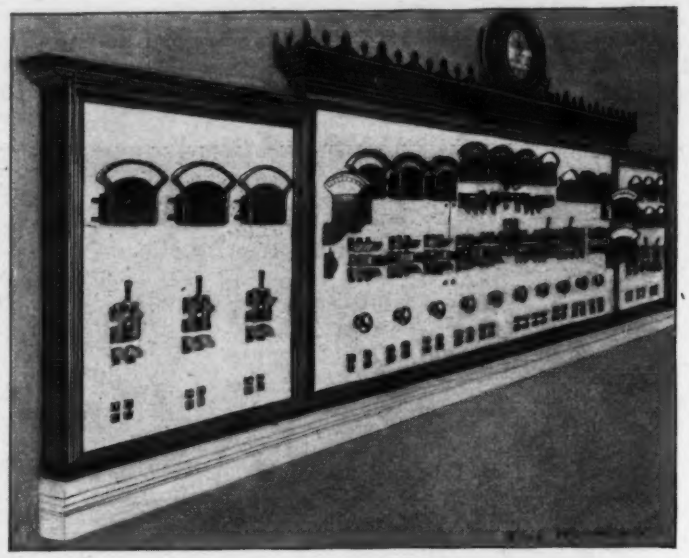


THE CHICAGO PUBLIC LIBRARY.

as it comes in and of ashes as it goes out. Underneath the court-yard floor are the coal-storage vaults, roomy enough to hold 300 tons of fuel.

The coal and ash handling machinery is rather simple, though most handy. From the wagon the coal is dumped into a five-ton hopper. It is then raised by a conveyor driven by an electric motor to a pair of pockets over the boiler room, from which it is sent down through a chute to the boiler floor, whence it is shoveled into the furnaces. No mechanical stoker is employed. The coal used is the best quality of anthracite of the size known as small egg. The ashes are conveyed in the same manner as the coal, to a hopper outside the building, from which they are dumped into wagons brought into the court.

The boiler-room floor is ten feet below the street level. Room in the building was extremely valuable, so the boiler equipment was contracted into a very small space. The boilers were consequently made of a special design of the water-tube type, by John Mohr & Sons, Chicago. They consist of four units in two batteries, containing 11,000 square feet of heating surface. Particular attention in their design was paid to every point that would make



THE SWITCHBOARD.

certain of a first-class performance in economical steam production. A special effort was made to secure a circulation of feed water that would insure the precipitation of all impurities in the large purifier installed.

Complete and compact as the boiler room is, these characteristics of the plant are not fully appreciated until the engine room is reached. This is far more compact and complete, reminding one by its large amount of power crowded into a small space and by the perfection of its details of the engine room of a transatlantic steamer. The engine-room floor, of iron, is about five feet below the street level, with a sub-basement under it. In the centre of the room, occupying almost the entire space, stand the engines with their direct-coupled generators. Along the north wall is a model switchboard. At the south end is a gauge room and gauge board, pumps and fan motors. At either side is an elevator shaft, with electric elevator motors and cable drums. Outside of the machinery there is barely room for the attendants to move about, except in front of the switchboard. The only spare corner is filled by Chief Engineer Rietz's desk and a wash-stand.

The engines are five in number, four of 250 horse-power apiece and one of 75 horse-power. The large ones are upright, non-condensing, cross-compounds, made by the Ball Engine Company of Erie, Pa. The fifth is from the same makers, but is a tandem compound. The cross-compounds have the fly and governor wheels in the centre between the housings. Inertia governors of the Rites type were installed, and particular attention bestowed to make them sensitive in regulating. In spite of the effort, however, certain electrical precautions have yet to be taken to prevent the lights jumping from the influence of the motor demands.

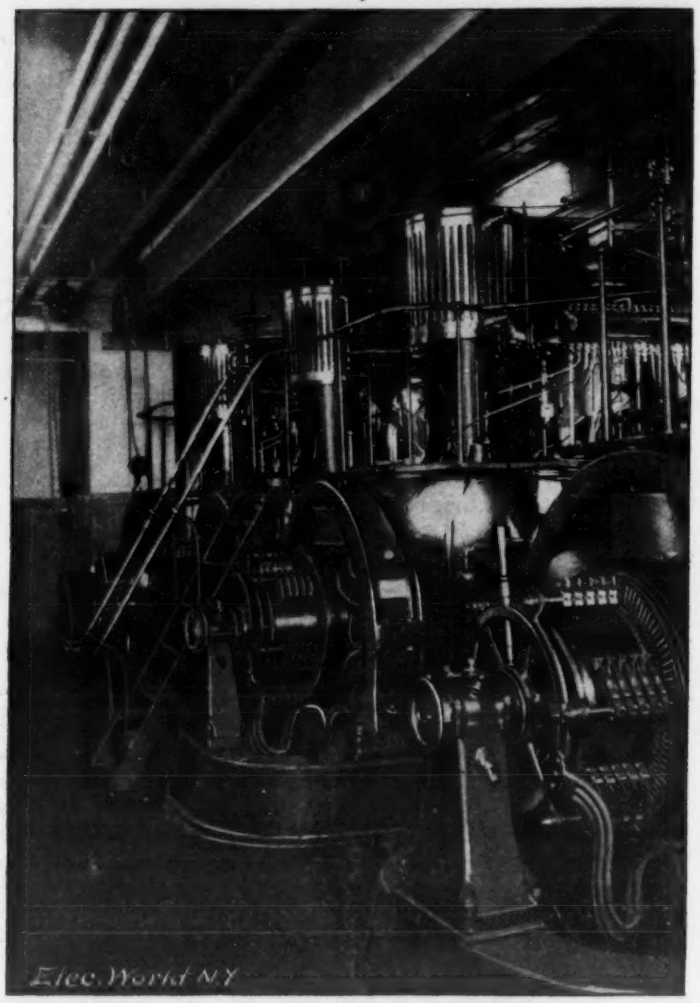
The gauge board in the back of the engine room is a novelty. It is built of white marble and bronze and adorned with no less than twelve gauges. There are gauges for the steam pressure, gauges for back pressure, gauges for the heating system, gauges for the air pressure, gauges to show the height of water in the tanks on the roof and gauges for everything an engineer could wish to keep track of. Back of the board is a little room kept under lock and key, and in it are all the recording gauges whose records can be of value.

Two six-pole 125-volt General Electric generators of 60 kilowatts each are direct coupled to each of the larger engines. The smaller engine has two of 22½ kilowatts each, making of all the units three-wire sets. The large ones are driven at 175 r. p. m. and the smaller ones at 305.

The Edison three-wire system is used throughout the building. On it are 13,000 16-cp 110-volt incandescent lamps, and a number of 220-volt motors. There are thirty-five of the latter, ranging in size from 1 to 30 horse-power. Ten Gibbs electric elevators are in the building, four of them being supplied with 30-hp motors and the rest with 22½-hp motors. The makes of motors used throughout the building include Gibbs, Crocker-Wheeler, C. & C, Westinghouse, Northern and International. They perform all the power work of the building, even to running the air compressor for the pneumatic tube system.

The switchboard is one in a thousand. It occupies the entire north side of the engine room. It is made of purest white Carrara marble, bound with a heavy ornamental border of solid bronze, costing several thousand dollars in itself. Above, the bronze trimming forms the frame for a handsome electrical clock, which runs by means of circuits twenty-eight electric clocks in the various rooms throughout the building. The copper instruments combine with the bronze and white of the board to give a most handsome effect. The board was installed by the Chicago Edison Company, which did the electrical work on the plant.

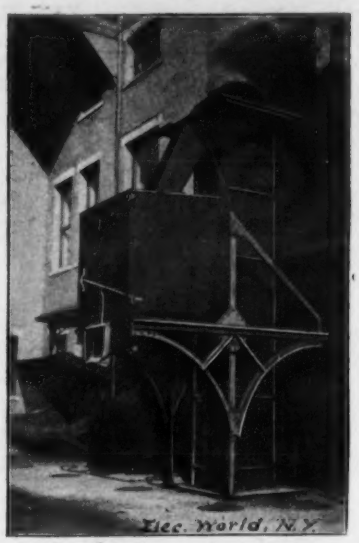
There are three panels to the switchboard. The centre one is the generator panel, holding the rheostats, ammeters and controlling switches for the machines. The main switches are triple-pole, double-throw, putting in the equalizer bar in each case before the outside bar. One throw connects the dynamo to the power circuit and the other to the lighting circuit. A central junction switch enables the power and lighting buses to be thrown together if desired. This is usually done during the day in order to make a load



THE MAIN GENERATING UNITS.

sufficiently heavy to be economical for one pair of machines. But it results in flickering lights when the elevator motors are started, in spite of the special governors. Yet in the daytime the lights in use are in the basement and corridors, so no harm is done. At nighttime, even if the two circuits are thrown together, no fluctuation is noticed, since the lights form the greater part of the load and the variation due to the motors is a small factor. Usually one pair of machines is run daytime, unless cloudy, and two to three pairs at night.

The left-hand panel feeds the motor circuits. They are put for convenience on three feeders, running to different portions of the building. The right-hand panel is for the lights and here again three circuits are used. Light and power voltmeters are on the board, attached to the bus bars of the two circuits. A novelty of considerable value consists in both light and power pilot wires run to the board from the extreme points of the building, so that the throw of the voltmeter switch will show in succession the voltage at different places in the structure.



ASH HOIST, CHUTE AND TANK, SHOWING COAL HOPPER AT THE LEFT.

In front of the switchboard are small air tubes, connected with the compressor which supplies air for the pneumatic-gate openers on the elevators and for the sewage ejectors. These tubes are used for blowing dirt off the boards and instruments. The generators are similarly provided. Behind the switchboard are located the wattmeters, of the Thomson integrating variety. These keep a close record on the energy used for both light and power circuits.

The wiring throughout the building is done in iron-armored conduits. The main cables are carried on insulators, but everything smaller is concealed and in conduits. Between the machine and switchboard and from the street to the building the cables run under the engine-room floor in the sub-basement to wiring shafts through the building. The largest cables contain 1,250,000 circular mils.

Tests have been recently completed on the Chicago Public Library plant by George H. Barrus. The results in full have not been given out. But they have occasioned some important changes lately in the electrical machinery—changes not yet fully completed. As far as published, the engines and boilers made a good showing. The dynamos gave an efficiency of 0.856 on full load, 0.785 on half load and 0.854 on 1¼ load.

This plant, designed by N. E. Wydert, is relied on for furnishing the lighting of the Chicago Public Library in every event. Although there are a few gas pipes in the building, no connection with the street mains has ever been made. Likewise, no breakdown connection with the Chicago Edison street circuit, now so common as a safety reserve in the down-town plants, has been provided. The usefulness of the building to the public is expected to stand or fall by its lighting plant. Judging by past records and the large reserve of machinery provided, the distribution of the 2,700,000 books given out by the Chicago Public Library each year will not be interfered with by lack of light or power.

Experiments with Electric Traction on the London Underground Railways.

The London "Electrical Engineer" announces a few details of the electrical traction experiments to be carried out on the Metropolitan and District railways of London. It is proposed to have the motors distributed among the different cars of the train, some four gearless motors with series-parallel control to be used for each train. Both lead and return conductors will be insulated, the train rails not being utilized for conduction purposes, and the present experiments are chiefly intended to ascertain the best arrangements of the conducting system. The experiments will be carried on until July.

The Resistance of the Human Body.

The London "Electrician" describes measurements carried on by Siemens & Halske to determine the resistance of the bodies of a large number of workmen. Between the hands values ranging from 900 to 2000 ohms were obtained, and between the hand and earth—the men wearing the wooden shoes of German workmen—resistance ran from 14,000 to over 150,000.

The Converter—I.

BY C. P. STEINMETZ.

1. GENERAL.

FOR long-distance transmission, and to a certain extent also for distribution, alternating currents, either polyphase or single phase, are extensively used. For many applications, however, as especially for electrical railroading and for electrolytic work, continuous currents are required, and are usually preferred also for low tension distribution on the Edison three-wire system. Thus, where power is derived from an alternating system, transforming devices are required to convert from alternating to continuous current. This can be done either by a direct-current generator driven by an alternating synchronous or induction motor, or by a single machine consuming alternating and producing continuous current in one and the same armature. Such a machine is called a converter and combines, to a certain extent, features of a direct-current generator and an alternating synchronous motor.

Since in the converter the alternating and the continuous currents pass through the same armature conductors, and therefore cut the same field flux, their e. m. fs. stand in a definite relation to each other, which is such that in practically all cases step-down transformers will be necessary to give from the comparatively high pressure line circuit the required alternating voltage.

Comparing the converter with the combination of a synchronous or induction motor and a direct-current generator, the converter requires step-down transformers, while the synchronous motor, if the alternating line voltage is 10,000 volts or more, generally requires step-down transformers also, but with voltages of 1000 to 10,000 volts the synchronous motor can frequently be wound directly for the line pressure and stationary transformers eliminated. Thus, in the one case, we have two machines with or generally without stationary transformers, and in the other case a single machine with transformers.

Regarding the reliability of operation and first cost, usually a single machine is preferable. Regarding efficiency, that of the stationary transformer of large size varies from 97 to 98 per cent., with an average of 97.5 per cent. That of the converter or of the synchronous motor varies between 91 and 95 per cent., with 93 per cent. as average, and that of the direct-current generator between 90 and 94 per cent., with 92 per cent as average. Thus the converter with its step-down transformers will give an average efficiency of 90.7 per cent., a direct-current generator driven by synchronous motor with step-down transformers an efficiency of 83.4 per cent., and without step-down transformers an efficiency of 85.5 per cent. Hence the converter is more efficient.

Mechanically the converter has the advantage that no transfer of mechanical energy takes place, since the torque consumed by the

Fig. 1

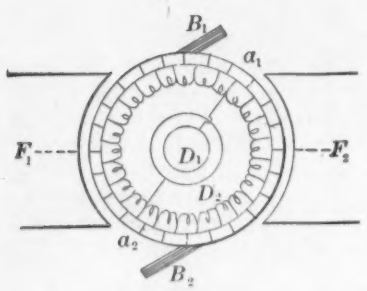
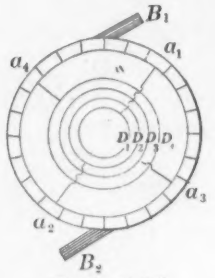


Fig. 2



Elec. World, N. Y.

generation of the continuous current and the torque produced by the alternating current are applied at the same armature conductors, while in a direct-current generator driven by synchronous motor the power has to be transmitted mechanically through the shaft.

2. RATIO OF ELECTROMOTIVE FORCES AND OF CURRENTS.

Let Fig. 1 represent diagrammatically the commutator of a direct-current machine with the armature coils shown connected to adjacent commutator bars. The brushes are B_1 and B_2 and the field poles F_1 and F_2.

If now two oppositely located points a_1 and a_2 of the commutator are connected with two collector rings D_1 and D_2 it is obvious that the e. m. f. between these points a_1 a_2 and thus between the collector

Fig. 3

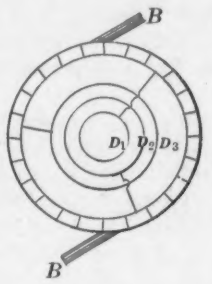
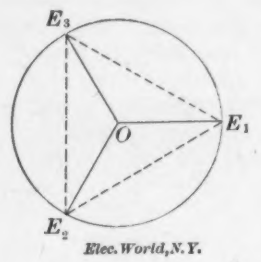


Fig. 4



Elec. World, N. Y.

rings D_1 D_2 will be a maximum at the instant when the points a_1 a_2 coincide with the brushes B_1 B_2, and will at this time be equal to the direct-current voltage E of the machine. While the points a_1 a_2 are moving away from this position the difference of potential between a_1 and a_2 decreases and becomes zero at the instant when the line a_1 a_2 coincides with the direction of the field poles F_1 F_2. At this point the difference in potential between a_1 and a_2 reverses and then increases again, reaching equality with E, but in opposite direction when a_1 and a_2 coincide with the brushes B_2 and B_1.

That is, between the collector rings D_1 and D_2 an alternating voltage is produced whose maximum value equals the continuous current e. m. f., E, and which makes a complete period for every revolution of the machine (in a bipolar converter, or p periods per revolution in a machine of $2p$ poles).

Hence this alternating e. m. f. is

$$e = E \sin 2\pi N t.$$

Where N = frequency of rotation and E = e. m. f. between brushes of the machine.

Thus the effective value of the alternating e. m. f. is

$$E_1 = E/\sqrt{2}.$$

That is, a direct-current machine produces between two collector rings connected with two opposite points of the commutator an alternating e. m. f., equal to the direct-current voltage, divided by the square root of two, at a frequency equal to the frequency of rotation, and since every alternating-current generator is reversible such a direct-current machine with two collector rings, when supplied with an alternating e. m. f. of $1/\sqrt{2} \times$ the direct-current voltage at the frequency of rotation, will run as a synchronous motor, or if at the same time generating direct current as a synchronous converter.

Since, neglecting losses and phase displacement, the output of the direct-current side must be equal to the input of the alternating-current side, and the alternating voltage in the single-phase converter is $E/\sqrt{2}$, the alternating current must be $= I\sqrt{2}$, where I = direct-current output.

If now the commutator is connected to a further pair of collector rings D_3 D_4 (Fig. 2) at two points a_3 a_4 midway between a_1 and a_2, it is obvious that between D_3 and D_4 an alternating voltage of the same frequency and intensity will be produced as between D_1 and D_2, but in quadrature therewith, since at the moment when a_3 and a_4 coincide with the brushes B_1 B_2, and thus receive the maximum difference of potential, a_1 and a_2 are at zero points of potential. Thus connecting four equidistant points a_1, a_2, a_3 and a_4 of the direct-current generator to four collector rings D_1, D_2, D_3 and D_4 gives a four-phase converter of the e. m. f. per phase.

$$E_1 = E/\sqrt{2}.$$

The current per phase is (neglecting losses and phase displacement)

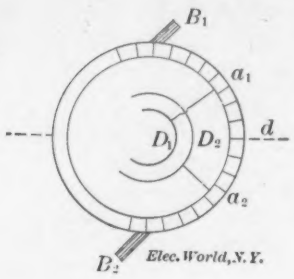
$$I_1 = I/\sqrt{2}.$$

since the alternating power $2E_1 I_1$ must equal the direct-current power, EI.

Connecting three equidistant points of the commutator to three collector rings, as in Fig. 3, gives a three-phase converter.

Let, in Fig. 4, the three e. m. fs. between the three collector rings and the neutral point of the three-phase system (or Y voltages) be represented by the vectors $O E_1$, $O E_2$ and $O E_3$, and the e. m. f. between the collector rings (or delta voltages), by vectors $E_1 E_2$, $E_2 E_3$ and $E_3 E_1$. The e. m. f. $O E_1$ is, however, nothing but half the e. m. f. E_1 in Fig. 1 of the single-phase converter, that

Fig. 5



is $= E/2\sqrt{2}$. Hence the Y voltage, or voltage between collector ring and neutral point of a three-phase converter, is

$$E_1 = \frac{E}{2\sqrt{2}},$$

and the $\triangle$ voltage thus,

$$E^1 = E_1\sqrt{3} = \frac{E\sqrt{3}}{2\sqrt{2}}.$$

Since the total three-phase power, $3 I_1 E_1$, equals the total continuous-current power $I E$, it is,

$$I_1 = \frac{I E}{3 E_1} = \frac{2 I\sqrt{2}}{3} = 0.943\, I.$$

In general, in an n-phase converter or converter in which n equidistant points of the commutator (in a bipolar machine, or n equidistant points per pair of poles in a multipolar machine) are connected to n collector rings, the voltage between any collector ring and the common neutral, or star voltage, is

$$E_1 = \frac{E}{2\sqrt{2}},$$

consequently the voltage between two adjacent collector rings

$$E^1 = 2 E_1 \sin\frac{\pi}{n} = \frac{E}{\sqrt{2}}\sin\frac{\pi}{n},$$

since $2\pi/n$ is the angular displacement between two adjacent collector rings, and herefrom the current per line is found as

$$I_1 = \frac{2 I\sqrt{2}}{n}$$

and the current flowing from line to line, or from collector ring to adjacent collector ring,

$$I^1 = \frac{I\sqrt{2}}{n\sin\frac{\pi}{n}}.$$

Table No. 1 gives, with the continuous-current voltage and continuous current as unit, the alternating voltages and currents of the different converters.

TABLE I.

	Continuous Current.	Single Phase.	Three Phase.	Four Phase.	Six Phase.	Twelve Phase.	n Phase.
Volts between collector ring and neutral point.		$\frac{1}{2\sqrt{2}} = .354$	$\frac{1}{2\sqrt{2}} = .354$	$\frac{1}{2\sqrt{2}} = .354$	$\frac{1}{2\sqrt{2}} = .354$	$\frac{1}{2\sqrt{2}} = .354$	$\frac{1}{2\sqrt{2}} = .354$
Volts between adjacent collector rings.	1.0	$\frac{1}{\sqrt{2}} = .707$	$\frac{\sqrt{3}}{2\sqrt{2}} = .612$	$\frac{1}{2} = .5$	$\frac{1}{2\sqrt{2}} = .354$	.183	$\frac{1}{\sqrt{2}\sin\pi/n}$
Amperes per line.	1.0	$\sqrt{2} = 1.414$	$\frac{2\sqrt{2}}{3} = .943$	$\frac{1}{\sqrt{2}} = .707$	$\frac{\sqrt{2}}{3} = .472$	.236	$\frac{2\sqrt{2}}{n}$
Amperes between adjacent lines.	1.0	$\sqrt{2} = 1.414$	$\frac{2\sqrt{2}}{3\sqrt{3}} = .545$	$\frac{1}{2} = .5$	$\frac{\sqrt{2}}{3} = .472$	.455	$\frac{\sqrt{2}}{n\sin\pi/n}$

These currents give only the energy component of alternating current corresponding to the continuous-current output. Added thereto is the current required to supply the losses in the machine, and the wattless component of current if a phase displacement is produced in the converter.

3. VARIATION OF THE RATIO OF ELECTROMOTIVE FORCES.

The preceding ratios of e. m. fs. apply strictly only to the induced e. m. fs., and that under the assumption of a sine wave of alternating induced e. m. f. The latter is always sufficiently closely the case, since the armature of the converter is a multitooth structure, that is, contains a distributed winding.

The ratio between the difference of potential at the commutator brushes and that at the collector rings of the converter usually differs somewhat from the theoretical ratio, due to the e. m. f. consumed in the converter armature, and in machines converting from alternating to continuous current also due to the shape of impressed wave. When converting from alternating to continuous current, under load the difference of potential at the commutator brushes is less than the induced continuous-current e. m. f., and the induced alternating e. m. f. less than the impressed, due to the voltage lost in the armature resistance.

If the current in the converter is in phase with the impressed e. m. f., armature self induction has little effect, but reduces the induced alternating e. m. f. below the impressed with a lagging, and raises it with a leading current, in the same way as in a synchronous motor.

Thus in general the ratio of voltages varies somewhat with the load and with the phase relation, and with constant impressed alternating e. m. f. the difference of potential at the commutator brushes decreases with increasing load, decreases with decreasing excitation, lag—and increases with increasing excitation, lead. When converting from continuous to alternating current the reverse is the case.

The direct-current voltage stands in definite proportion to the maximum instantaneous value of the alternating voltage (being equal to twice the maximum star voltage), but to the effective value (or value read by the voltmeter) only in so far as the latter depends upon the former, being equal, with a sine wave, to $1/\sqrt{2}$, multiplied by the maximum value. Thus with an impressed wave of e. m. f. giving a different ratio of maximum to effective value, the ratio between continuous-current and alternating-current voltage is changed in the same proportion as the ratio of maximum to effective. Thus, for instance, with a flat-topped wave of impressed e. m. f. the maximum value of alternating impressed e. m. f. and thus the continuous-current voltage depending thereupon are lower than with a sine wave of the same effective value, while with a peaked wave of impressed e. m. f. they are higher by as much as 10 per cent. in extreme cases.

Hence the ratios of e. m. fs. given under heading 2 have to be corrected by the drop of voltage in the armature, and have to be multiplied by a factor which is $\sqrt{2}$ times the ratio of effective to maximum value of impressed wave of e. m. f. ($\sqrt{2}$ being the ratio of maximum to effective of the sine wave on which the ratios in section 2 were based.) With an impressed wave differing from sine shape, a current of higher frequency, but generally of negligible

Fig. 5

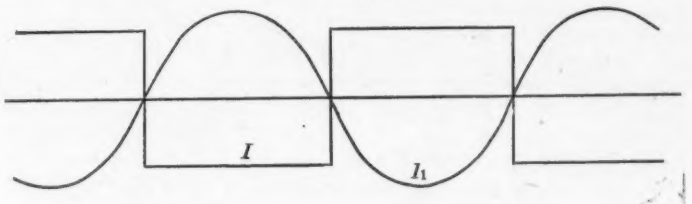
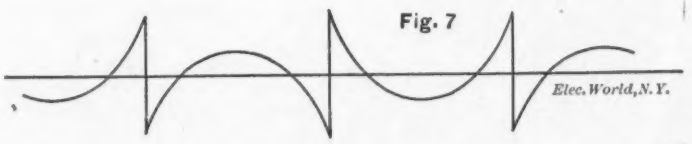


Fig. 7



magnitude, flows through the converter armature, due to the difference between impressed and counter e. m. f. waves.

4. ARMATURE CURRENT AND HEATING.

The current flowing in the armature conductors of a converter is the difference between the alternating-current input and the continuous-current output.

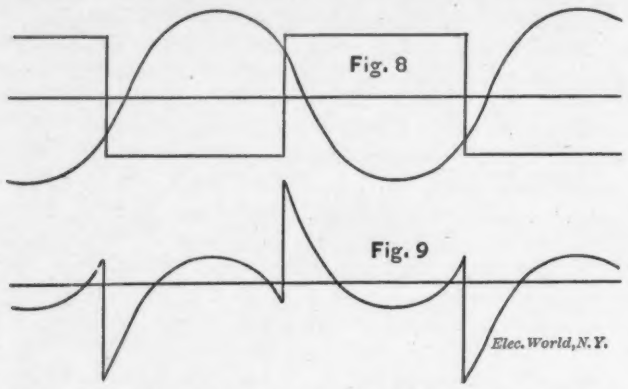
Let in Fig. 5 a_1 and a_2 be two adjacent leads connected with the

collector rings D_1 and D_2 of an n-phase converter. The alternating e. m. f. between a_1 and a_2, and thus the alternating energy current flowing in the armature section between a_1 and a_2, will reach a maximum when this section is midways between the brushes B_1 and B_2, as shown in Fig. 5.

The continuous current in every armature coil reverses at the moment when the coil passes under brush B_1 or B_2, thus giving a rectangular alternating current, as shown in Fig. 6 as I. At the moment when the alternating energy current is a maximum, an armature coil d midway between two adjacent alternating leads a_1 and a_2 is midway between the brushes B_1 and B_2, as in Fig. 5, and is thus in the middle of its rectangular continuous-current wave, and consequently in this coil the alternating and the rectangular continuous current are in phase with each other, but opposite, as shown in Fig. 6 at I_1 and I, and the actual current is their difference, as shown in Fig. 7.

In successive armature coils the continuous current reverses successively. That is, the rectangular currents flowing in successive armature coils are successively displaced in phase from each other, and since the alternating current is the same in the whole section a_1 a_2 and in phase with the rectangular current in the coil d it becomes more and more out of phase therewith when passing from coil d towards a_1 or a_2, as shown in Figs. 8, 9, 10 and 11, until the maximum phase displacement between alternating and rectangular current is reached at the alternating leads a_1 and a_2, and is equal to π/n.

Thus if $E =$ continuous voltage and $I =$ continuous current, in an armature coil displaced by angle ω from the position d midway between two adjacent leads of the n-phase converter, if the



continuous current is $I/2$ for the half period from zero to π the alternating current is

$$I^1 \sqrt{2} \sin (\varphi - \omega)$$

where

$$I^1 = \frac{I \sqrt{2}}{n \sin \pi/n}$$

is the effective value of the alternating current. Thus the actual current in this armature coil is,

$$i_o = I^1 \sin (\varphi - \omega) - \frac{I}{2} = \frac{I}{2} \left\{ \frac{4 \sin (\varphi - \omega)}{n \sin \pi/n} - 1 \right\}$$

and its effective value,

$$I_o = \sqrt{\frac{1}{\pi} \int_o^\pi i_o^2 d\varphi} = \frac{1}{2} \sqrt{\frac{1}{\pi} \int_o^\pi \left\{ \frac{4 \sin (\varphi - \omega)}{n \sin \pi/n} - 1 \right\}^2 d\varphi}$$

$$= \frac{I}{2} \sqrt{\frac{8}{n^2 \sin^2 \pi/n} + 1 - \frac{16 \cos \omega}{n \sin \pi/n}}.$$

Since $\frac{I}{2}$ is the current in the armature coil of a direct-current generator of the same output,

$$\Gamma\omega = \left(\frac{I_o}{I/2} \right)^2 = \frac{8}{n^2 \sin^2 \pi/n} + 1 - \frac{16 \cos \omega}{n \pi \sin \pi/n}$$

is the ratio of the energy loss in the armature-coil resistance of the converter to that of the direct-current generator of the same output, and thus the ratio of coil heating.

This ratio is a maximum at the position of the alternating leads: $\omega = \pi/n$ and is:

$$\Gamma_m = \frac{8}{n^2 \sin^2 \pi/n} + 1 - \frac{16 \cos \pi/n}{n \pi \sin \pi/n}.$$

It is a minimum for a coil midways between adjacent alternating leads: $\omega = 0$ and is:

$$\Gamma_o = \frac{8}{n^2 \sin^2 \pi/n} + 1 - \frac{16}{n \pi \sin \pi/n}.$$

Integrating over ω from 0 (coil d) to π/n, that is, over the whole phase or section a_1 a_2,

$$\Gamma = \frac{n}{\pi} \int_0^{\frac{\pi}{n}} \Gamma\omega \, d\omega = \frac{8}{n^2 \sin^2 \pi/n} + 1 - \frac{16}{\pi^2}$$

is the ratio of the total energy loss in the armature resistance of an n-phase converter to that of the same machine as direct-current generator at the same output, or the relative armature heating.

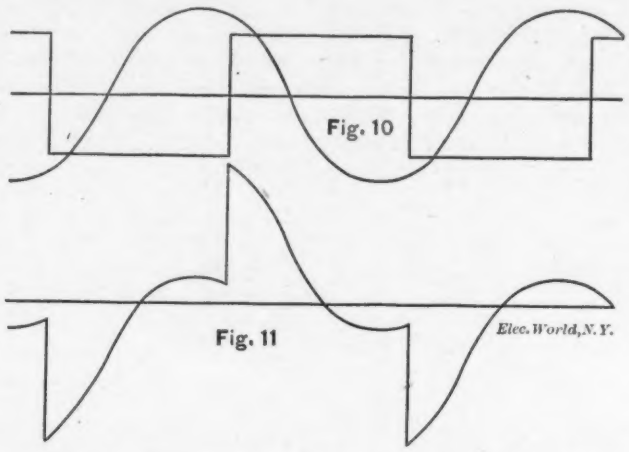
Thus, to get the same energy loss in the armature conductors and consequently the same heating of the armature, the current in the converter, and thus its output, can be increased in the proportion $1/\sqrt{\Gamma}$ over that of the direct-current generator.

SUBSTITUTING FOR n NUMERICAL VALUES.

Type.	Continuous Current Generator.	Single Phase.	Three Phase.	Four Phase.	Six Phase.	Twelve Phase.	∞ Phase *
n		2	3	4	6	12	
Γ_o	1.00	0.45	0 225	0.20	0.19	0.187	0.187
Γ_m	1.00	3.00	1.20	0.73	0.42	0.24	
Γ	1.00	1.37	0.555	0.37	0.26	0.20	
Rating by mean armature heating	1.00	0.85	1.34	1.64	1.96	2.24	2.31

* That is, as many collector rings as commutator segments.

In these values the small energy current supplying the losses in the converter is neglected.



Assuming this current $= \rho I$, where I equals the energy current corresponding to continuous current (where $\rho = 0.04$ when assuming 4 per cent. loss in mechanical and molecular magnetic friction), the total alternating energy current is:

$$I_1^1 = I^1 (1 + \rho)$$

and the resultant current

$$i_o^1 = I_1^1 \sin (\varphi - \omega) - \frac{I}{2}$$

$$= \frac{I}{2} \left\{ \frac{4 (1 + \rho) \sin (\varphi - \omega)}{n \sin \pi/n} - 1 \right\}$$

thus its effective value:

$$I_o^1 = \sqrt{\frac{1}{\pi} \int_o^\pi i_o^1 \, di}$$

$$= \frac{I}{2} \sqrt{\frac{8 (1 + \rho)^2}{n^2 \sin^2 \pi/n} + 1 - \frac{16 (1 + \rho) \cos \omega}{n \pi \sin \pi/n}}$$

hence,

$$\Gamma^1\omega = \left(\frac{I_o^1}{I/2} \right)^2 = \frac{8 (1 + \rho)^2}{n^2 \sin^2 \pi/n} + 1 - \frac{16 (1 + \rho) \cos \omega}{n \pi \sin \pi/n}$$

$$= \Gamma\omega + 2 \rho \left\{ \frac{8}{n^2 \sin^2 \pi/n} - \frac{8 \cos \omega}{n \pi \sin \pi/n} \right\}$$

integrated over ω from 0 to π/n

$$\Gamma^1 = \frac{n}{\pi} \int_0^{\frac{\pi}{n}} \Gamma^1\omega \, I \, d\omega = \Gamma + 2 \rho \left\{ \frac{8}{n^2 \sin^2 \pi/n} - \frac{8}{\pi^2} \right\}$$

$$\Gamma^1 = \Gamma (1 + 2\rho) - 2 \rho (1 - 8/\pi^2)$$

$$= (1 + 2\rho) \left\{ \frac{8}{n^2 \sin^2 \pi/n} + 1 - \frac{16}{\pi^2} \right\} - 2 \rho (1 - 8/\pi^2)$$

Herefrom we get the values for the relative current heating, Γ^1, and the corresponding rating, which is $1/\sqrt{\Gamma^1}$ by assuming $\rho = 0.04$.

Type.	Continuous Current.	Single Phase.	Three Phase.	Four Phase.	Six Phase.	Twelve Phase.	∝ Phase.
I =	1.00	1.37	0 555	0.37	0.26	0.20	0.187
I^1 =	1.00	1.457	0.585	0.385	0.267	0.201	0.187
Rating	1.00	0.825	1.31	1.61	1.94	2.24	2.31

If a phase displacement exists between current and e. m. f. in the converter, the current can be resolved into an energy component in phase with the e. m. f. and a wattless component in quadrature therewith.

The loss of power in a resistance due to an alternating curent is equal to the sum of the losses due to the two components, the energy current and the wattless current, and thus if a phase displacement is produced in a converter the loss of power due to the wattless current has to be added to the loss of power due to the energy current as discussed and recorded in above given tables.

Assuming, for instance, a wattless current at full load (leading or lagging) of 30 per cent. of full load current, the additional energy loss in the armature corresponding thereto amounts to $0.3^2 = 0.09$ of that of the same machine as a direct-current generator. Adding this to the values given in above tables gives a relative heating of the different types of machines, and permissible rating (as based on armature heating) as follows:

30 PER CENT. WATTLESS CURRENT.

Type.	Continuous Current.	Single Phase.	Three Phase.	Four Phase.	Six Phase.	Twelve Phase.	∝ Phase.
I^1 =	1.00	1.475	0.585	0.385	0.267	0.201	0.276
I_0 =	1.00	1.565	0.675	0.475	0.327	0.291	0.277
Rating	1.00	0.80	1.22	1.45	1,67	1.85	1.90

5. ARMATURE REACTION.

The armature reaction of the polyphase converter is the resultant of the direct-current and the alternating-current reactions. If the commutator brushes are set at right angles to the field poles or without lead or lag, as is usually done in converters, the continuous-current armature reaction consists in a polarization in quadrature behind the field magnetism. The armature reaction due to the energy component of the alternating current in a synchronous motor consists in a polarization in quadrature ahead of the field magnetism, and thus is opposite to the armature reaction as a continuou-current generator.

Let m be the total number of turns on the bipolar armature of an n-phase converter, and I be the continuous current, then the number of turns in series between the brushes equals $m/2$, hence the total armature ampere turns or polarization equals $m/2$. Since however, these ampere turns are not unidirectional, but distributed over the whole surface of the armature, their resultant is:

$$F = \frac{m\ I}{2} \text{ avg. cos} \Big|_{-\frac{\pi}{2}}^{+\frac{\pi}{2}}$$

$$\text{And since avg. cos} \Big|_{-\frac{\pi}{2}}^{+\frac{\pi}{2}} = \frac{2}{\pi}$$

$F = m\ I / \pi$ = continuous-current polarization of the converter (or direct-current generator) armature.

In an n-phase converter the number of turns per phase equals m/n. The current per phase or current between two adjacent leads (ring current) is

$$I^1 = \frac{I\sqrt{2}}{n \sin \pi/n}$$

hence the ampere turns per phase are

$$\frac{m\ I^1}{n} = \frac{m\ I\sqrt{2}}{n^2 \sin\ \pi/n}.$$

These ampere turns are distributed over one n-th of the circumference of the armature, and their resultant is thus:

$$f^1 = \frac{m\ I^1}{n} \text{ avg. cos} \Big|_{-\frac{\pi}{n}}^{+\frac{\pi}{n}}$$

$$\text{And since avg. cos} \Big|_{-\frac{\pi}{n}}^{+\frac{\pi}{n}} = \frac{n}{\pi} \sin \frac{\pi}{n}$$

$$f^1 = \frac{m\ I\sqrt{2}}{\pi\ n}$$

is the resultant polarization in effective ampere turns of one phase of the converter.

Thus the total polarization of all n-phases* is

$$F^1 = \frac{n\sqrt{2}}{2} f^1 = \frac{m\ I}{\pi}$$

that is, the polarization of the converter due to the alternating energy current is equal to that of the continuous current, but opposite thereto, and their resultant armature reaction is thus equal to zero. The same is obviously the case in an "inverted converter," that is, a machine changing from continuous to alternating current.

Different, however, are the conditions in a single-phase converter. At the instant when the alternating current equals zero the full continuous-current reaction exists.

At the instant when the alternating current is a maximum, the reaction is the difference between that of the alternating and of the continuous current, and since the maximum alternating current in the single-phase converter equals twice the continuous current, at this instant the resultant armature reaction is equal but opposite to the continuous-current reaction.

Hence the armature reaction oscillates with twice the frequency of the alternating current, and with full intensity; and since it is in quadrature with the field excitation, tends to shift the magnetic flux rapidly across the field poles, and thereby tends to cause sparking and energy losses. This oscillating reaction is, however, essentially reduced by the damping effect of the magnetic field structure.

Since the resultant main armature reactions neutralize each other in the polyphase converter, there remain only:

1. The armature reaction due to the small energy current required to cover the internal losses of power, which is in quadrature with the field excitation or distorting, but of negligible magnitude;

2. The armature reaction due to the wattless component of alternating current where such exists; and

3. An effect of oscillating nature, which may be called a "higher harmonic of armature reaction."

The continuous current, as a rectangular alternating current in the armature, changes in phase from coil to coil, while the alternating current is the same in the whole section of the armature between adjacent leads.

Thus, while the resultant reactions neutralize, a local effect remains, which in its relation to the magnetic field oscillates with a period equal to the time of the motion of the armature through the angle between adjacent alternating leads, that is, double frequency in a single-phase converter (in which it is equal in magnitude to the continuous-current reaction, and is the oscillating armature reaction discussed above), triple frequency in a three-phase converter, and quadruple frequency in a four-phase converter.

The amplitude of this oscillation in a polyphase converter is small, and its influence upon the magnetic field is usually negligible, due to the damping effect of the field winding, which acts like a short-circuit for an oscillation of magnetism.

A polyphase converter on unbalanced circuit can be considered as a combination of a balanced polyphase and a single-phase converter, and since even single-phase converters operate fairly satisfactorily, the effect of unbalanced circuits on the polyphase converter is comparatively small.

Since the armature reaction of the continuous current and of the alternating current in the converter neutralize each other, no change of field excitation is required in the converter with changes of load. Furthermore, while in a continuous-current generator the armature reaction at given field strength is limited by the distortion of the field caused thereby, this limitation does not exist in a converter, and a much greater armature reaction can be safely used in converters than in continuous-current generators, the distortion being absent in the former.

Since the armature heating is relatively small, the practical limit of overload capacity of a converter is that due to the commutator, and is usually far higher than in a continuous-current generator, since the distortion of field which causes sparking on the commutator under overloads in a continuous-current generator is absent in a converter.

The theoretical limit of overload, that is, the overload at which the converter drops out of step and comes to a standstill, is far beyond reach at steady frequency and constant impressed alternating voltage, while on an alternating circuit of pulsating frequency it obviously depends upon the amplitude and period of the pulsation of frequency.

(To be continued.)

* "Theory and Calculation of Alternate-Current Phenomena," Steinmetz, p. 354, 1st ed.; p. 360, 2d ed.

The Paris Exposition of 1900.

BY FRANCIS E. DRAKE, DIRECTOR OF MACHINERY AND ELECTRICITY, UNITED STATES COMMISSION.

Though occupying only about one-half the area of the World's Columbian Exposition at Chicago, the Paris Exposition of 1900 will have great opportunity for the satisfactory presentation of the arts of peace. The location of the grounds is practically in the heart of Paris, and, lying as they do, on both sides of the River Seine, they afford an unrivalled opportunity for providing comfortably for great crowds.

The part which machinery and electricity will play in this coming exposition is a more important one than ever assumed by these two great industries in former expositions. In a general way it may be said that but few important changes or improvements will be shown in the service of the Paris exposition over the Columbian exposition of 1893. The French classification, however, is a distinct advance over that of any previous exposition, inasmuch as it provides for the installation of the finished product, together with the machinery and processes used in connection therewith. Under this classification collective exhibits will be most successful in presenting to the visitors a clear understanding of the state of the art in that particular industry.

The great service power plant of the exposition will occupy a favorable position in the main group of buildings. It will be installed immediately adjoining the space allotted for the exhibits of electrical and other machinery, and any benefit which might naturally accrue to the builder of machinery installed in the service plant will be accentuated and made more apparent by reason of its being located in close proximity to the exhibits not offered for regular service. The capacity of the boiler plant for the service of the exposition will be approximately 20,000 horse-power. The two plants will feed into one general system of mains and distributers, and either, or both, may be utilized at the same time, as occasion requires.

The engines and generators for this power plant will be placed in close proximity to the underground subways, carrying the steam and other mains. Each power unit must be of the direct-connected type, the generator armature being mounted direct upon the extended shaft of the engine. The designation of these units, according to the exposition nomenclature, will be "Electrogene Groups." It is proposed by the administration to divide the total power comprised in the various electrogene groups required, equally among the French and foreign builders. From present indications, manufacturers will offer electrogene groups largely in excess of the requirements of the exposition. No actual contracts have as yet been made for them for either the French or foreign sections, except a nominal arrangement entered into some time ago with three German manufacturers, who desire to furnish an aggregate approximating 5000 horse-power.

The location of the electrogene groups operating as generating units for the power plant will be within the regular exhibit space devoted to the Department of Machinery and Electricity. Electricity will furnish the motive power for the operation of an intramural elevated railway, which will encircle the Champs de Mars, pass in front of the main palace on the Esplanade des Invalides, and along the Quai d'Orsay from the Bridge of Alexander III. to the Eiffel Tower.

Not all of the main palaces will be lighted at night. The Palace of Manufacturers, Palace of Electricity, Palace of Transportation and Civil Engineering, Palace of Textiles, and perhaps one or two other palaces will be well illuminated every evening. The great Hall of Fêtes, which occupies a central position in the Palace of Agriculture, will be illuminated brilliantly whenever in use for evening gatherings. The Palace of Education and Liberal Arts, Palace of Mines and Metallurgy, Palace of Chemical Industries, and Palace of Agriculture will not be equipped for evening illumination.

It is the Palace of Electricity to which all eyes will naturally turn at night, and, as its main façade reaches across the entire width of the open Plaza in the centre of the Champs de Mars, splendid opportunity will be afforded for the attractive treatment of the architectural features of the exterior of this palace. Immediately in front of the Palace of Electricity is the grand Chateau d'Eau, which, as planned, will assume the character of an immense fountain with a series of cascades, all to be effectively illuminated by vari-colored lights, thus making a most brilliant and striking attraction for the evening. A very ingenious scheme has been undertaken in connection with this Chateau d'Eau. All of the water used in the power plant for condensing purposes is to be discharged through the Chateau d'Eau, and the cascades surrounding it, thus making use of this water in artistic effects, and obviating the necessity of pumping from the river another great volume of water simply for fountain use.

There will be no regular compressed-air service established by the exposition administration, but arrangements will be made with the City Public Service Company whereby compressed-air mains will be brought into the exposition buildings and air service offered to the exhibitors at the regular city rates, less 10 per cent.

The administration has considered well the necessity for making the gallery space in the various palaces as accessible to the public as possible, and provision has been made not only for numerous vertical elevators of steam, electric or hydraulic type, but for a large number of inclined elevating ways, or "rolling carpets," to carry the passengers easily and speedily from the crowded ground floor to the galleries, where many interesting and instructive exhibits will be installed. The limited ground area at this exposition makes necessary the husbanding of all available gallery space. On the Champs de Mars there will be installed fourteen of these elevators, or "escaladers," which will have a capacity each of not less than three thousand passengers per hour. A fee not exceeding 2 cents for each passenger will be charged for the use of these "escaladers."

The exhibit of automobiles, or horseless carriages, trolley cars, railway trains, etc., will be made in the special pavilions provided at the annex in the park at Vincennes. A special track will be provided there for trials and tests, and for the daily speeding of the various automobiles, bicycles, tricycles, etc. The electric vehicle is at present very popular in Paris, and will no doubt come in for its full share of interest.

In addition to the contemporary exposition, the official classification provides for the installation of a retrospective exhibit which shall present a historical view of the progress in all branches of industry during this century. The department of electricity has been specially favored in this regard by the construction of a special Salon d'Honneur within the Palace of Electricity, where the retrospective exhibit covering the great field of electricity may be properly undertaken, and where the personal exhibits of the great inventors of the century, and the collective exhibits of associations or individuals may, in their several ways, illustrate the evolution and advance of science.

For the information of those interested in the organization of the technical service under the director-general of exploitation it is desirable to state that the mechanical installations will be under the immediate direction of Monsieur Ch. Bourdon, professor of the Central School of Arts and Manufactures. The work of this departments falls under two distinct categories. The first relates to the execution of the necessary installations for motive power, and may be subdivided as follows:

(a)

PRODUCTION OF STEAM,

1st, Installation of Boilers,

2d, Construction of Flues and Chimneys.

(b)

DISTRIBUTION OF WATER AND STEAM,

1st, Construction of Subways,

2d, Installation of Steam Mains, Etc.

(c)

PRODUCTION OF POWER.

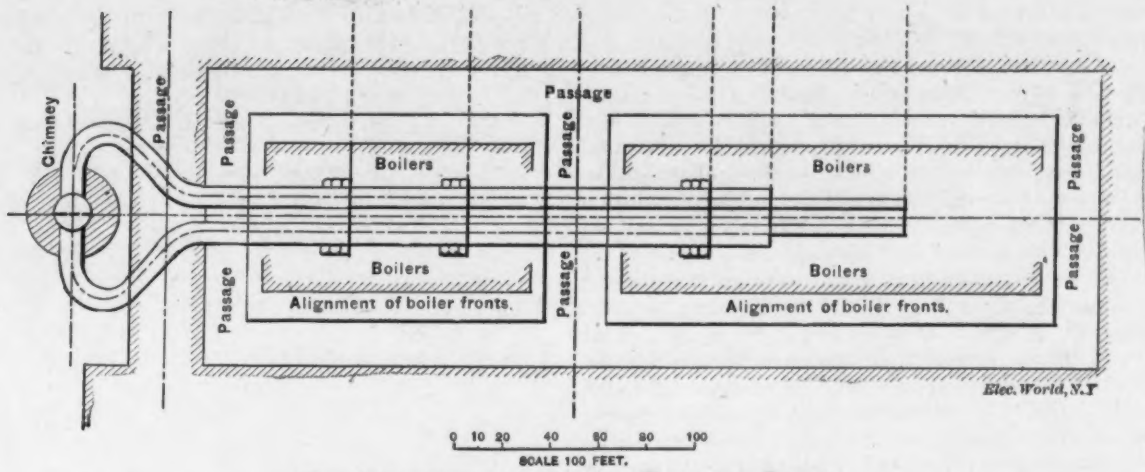
Installation of Electrogene Groups.

The distribution of motive power is practically assigned to the service of electric installations.

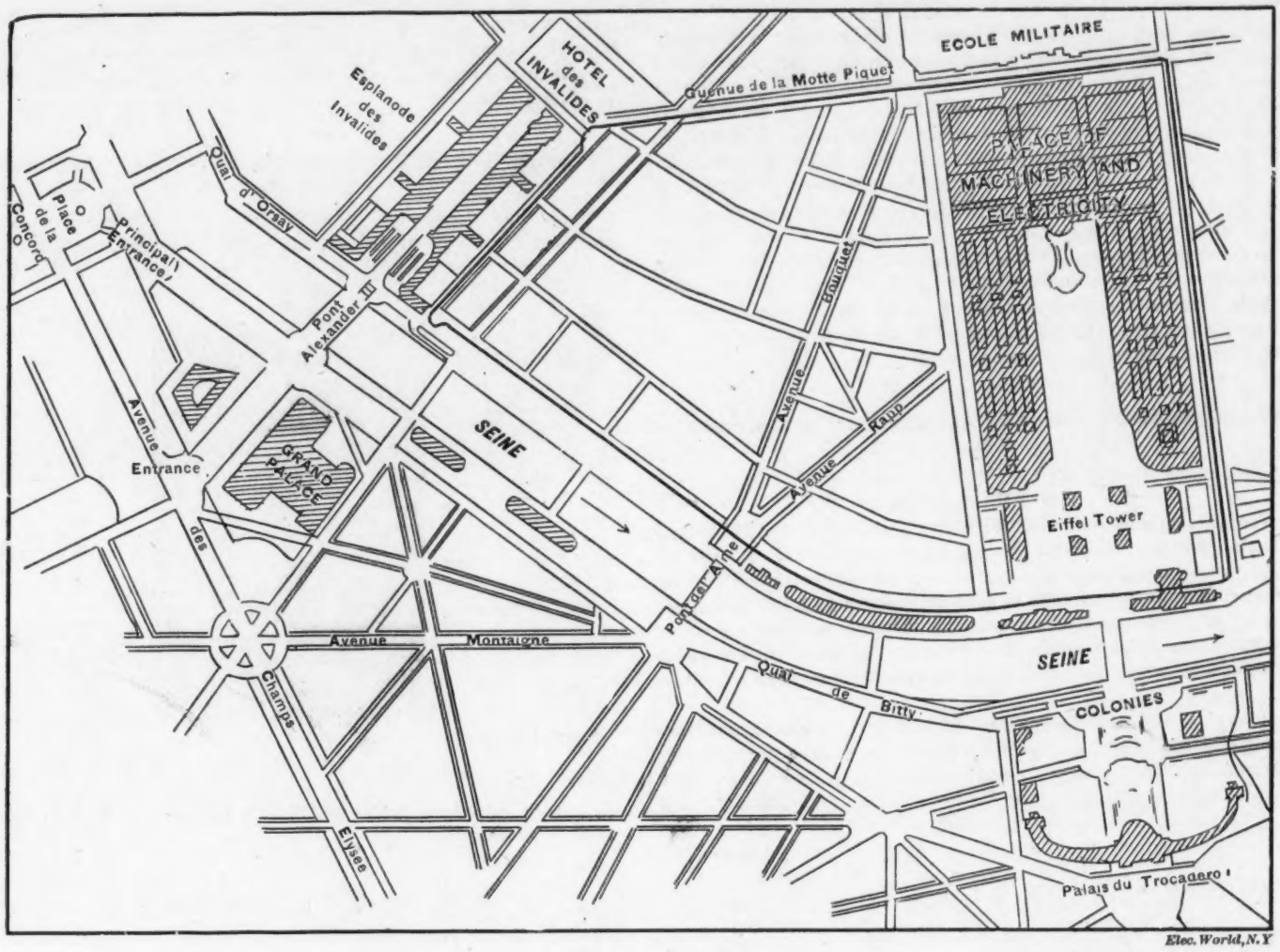
The work under the second category is of an administrative order, and especially concerns the general conditions of exploitation of the boilers and electrogene groups and such other apparatus as is required for the furnishing of the steam for power service.

The total mechanical power furnished will be in the neighborhood of 20,000 horse-power, of which 15,000 horse-power will be for electric lighting and 5000 horse-power for motor service. These figures, while not absolutely correct, are those used by the administration as the basis of the installation.

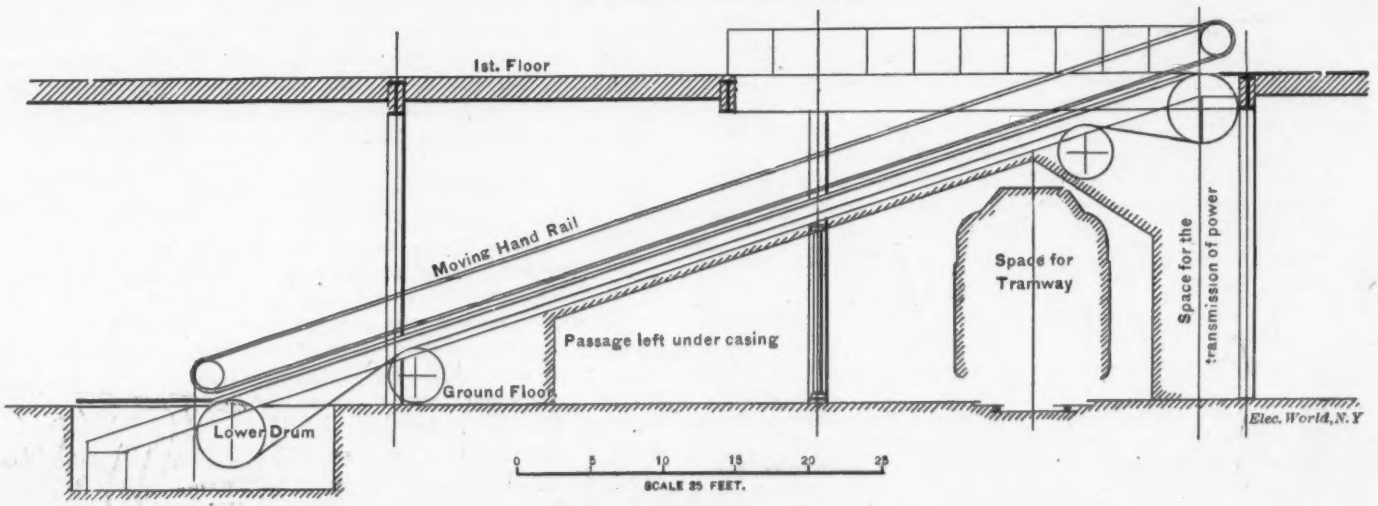
In the two power plants the boilers will be placed in two lines of batteries, with the boilers back to back. Ample space for general circulation of the public has been provided. The controlling minds of this great undertaking have not lost sight of the artistic side of



THE ARRANGEMENT OF BOILERS, FLUES AND STACKS.



A PLAN OF THE GROUNDS.



THE INCLINED ELEVATOR.

questions surrounding the service power plant, and in the construction of the chimneys for the two boiler plants ample provision has been made for the æsthetic treatment of the exterior of the towering stacks which will conduct the gas from the furnaces.

In appropriating funds for the power plant the administration has, upon the advice of the technical committee, provided a minimum sum, which may be said to be only about one-third of the allowance made for the use of power units at the Columbian Exposition of 1893. The great commercial rivalry between the principal nations of Europe has been a factor in determining the course of the administration. Many large concerns would have granted the use of engines and dynamos during the period of the exposition without charge, providing advantageous arrangement of space, etc., could have been assured them. It was after mature deliberation, however, that the authorities settled upon a very nominal compensation which should apply alike to French and foreign manufacturers.

A new feature of the exposition service is the "escalader," an inclined elevating way, constructed in the form of an endless carpet or belt, propelled by a drum at one end. No former exposition has made such generous provisions for means of carrying the public to the galleries, and as the typical "escalader" has been so recently brought into public use, nearly every one in the commercial world will be anxious to see the results obtained with it. The extent to which the elevating stairway may be successfully used can scarcely be estimated at this time. They are safe, easily installed, simple to operate, and have a capacity far in excess of vertical elevators so far as transportation from floor to floor of large crowds is concerned. Such devices have long been sought for large stores, elevated railway stations, etc. It may, therefore, be of interest to many to read the general programme for the competition open to French constructors for the large number of "escaladers" required. Privilege has been granted the Commissioner-General for the United States to install a working exhibit of one or more of these "inclines," in or near some United States section.

The Electromotive Force of an Asymmetrical Arrangement of Cells.

BY WM. A. LUBY.

Given an asymmetrical multiple-series arrangement of cells, each having an internal resistance, r, and a constant e. m. f., e. Let the number of series-groups 1, 2, 3, etc., in parallel with each other, be s, and the number of cells in each series-groups be n_1, n_2, n_3, etc. Further let the terminals be connected through an external resistance R. Then we can obtain an expression for the e. m. f. between the terminals, which becomes independent of r and R on open circuit.

Let c_1, c_2, c_3 and c_4 be the currents flowing in the paths numbered respectively 1, 2, 3 and 4. Then Kirchhoff's laws give the following equations:

$$n_1 r c_1 + R c_4 = n_1 e \quad (1)$$
$$n_2 r c_2 + R c_4 = n_2 e \quad (2)$$
$$n_3 r c_3 + R c_4 = n_3 e \quad (3)$$
$$c_1 + c_2 + c_3 - c_4 = 0 \quad (4)$$

The expression:

$$\frac{\begin{Vmatrix} n_1 r & 0 & 0 & n_1 e \\ 0 & n_2 r & 0 & n_2 e \\ 0 & 0 & n_3 r & n_3 e \\ 1 & 1 & 1 & 0 \end{Vmatrix}}{\begin{Vmatrix} n_1 r & 0 & 0 & R \\ 0 & n_2 r & 0 & R \\ 0 & 0 & n_3 r & R \\ 1 & 1 & 1 & -1 \end{Vmatrix}} = c_4 \quad (5)$$

which becomes

$$\frac{3 n_1 n_2 n_3 e}{n_1 n_2 n_3 r + R (n_1 n_2 + n_2 n_3 + n_3 n_1)} \quad (6)$$

or

$$R c_4 = \frac{3 n_1 n_2 n_3 e}{n_1 n_2 + n_2 n_3 + n_3 n_1 + \frac{n_1 n_2 n_3 r}{R}} \quad (7)$$

But $R c_4$ = the e. m. f. between A and B or the fall of potential over the path $A R B$. When R becomes very large $\frac{n_1 n_2 n_3 r}{R}$ becomes inconsiderable and on open circuit, when R = infinity, zero.

It can be seen in the simplification of the determinants (5) that the numerical coefficient of (6) 3 will always be equal to s, the number of series groups, the numerator of the expression being

$$s e (n^1 n^2 n^3 \ldots\ldots n_p)$$

and the denominator being the sum of the following numbers:

$$(n_1 n_2 n_3 \ldots . n_p) \frac{r}{R}$$
$$(n_2 n_3 n_4 \ldots\ldots n_p - 1\ n_p)$$
$$(n_1 n_3 n_4 \ldots\ldots n_p - 1\ n_p)$$
$$(n_1 n_2 n_4 \ldots\ldots n_p - 1\ n_p)$$
$$\ldots\ldots\ldots\ldots\ldots\ldots$$
$$\ldots\ldots\ldots\ldots\ldots\ldots$$
$$(n_1 n_2 n_3 n_4 \ldots\ldots n_p - 2\ n_p)$$
$$(n_1 n_2 n_3 n_4 \ldots\ldots n_p - 2\ n_p - 1)$$

Or when $s = 3$ this becomes

$$\frac{3 e n_1 n_2 n_3}{(n_1 n_2 n_3) \frac{r}{R} + n_1 n_2 + n_2 n_3 + n_3 n_1}$$

In practice, of course, polarization would affect the results. However, the voltage of a number of Daniell cells, measured by a high resistance voltmeter, would closely agree with the value computed by above formula.

Colonel Eugene Griffin on Modern Science in Warfare.

At the dinner given by officers of the First Regiment of Volunteer Engineers in honor of their colonel, Eugene Griffin, the latter made an address, outlining the history of the regiment during the late

Col. Eugene Griffin.

war, from which the following remarks of interest concerning the work during hostilities of engineers in general have been quoted:

"However necessary it may have been to prove the value of engineer troops under the ordinary conditions of modern warfare, every military man would have recognized the necessity and value of engineers in siege operations. The opportunity would have been offered us to introduce modern engineering methods and to change in many ways the traditional methods for the 'attack of fortified places.' Searchlights would have prevented sorties, and electric motors would have played no small part in the trenches. Hospitals would have been lighted by electricity and cooled by fan motors. The wounded on the battlefield would have been found at night by the aid of searchlights, and the surgeons would have operated in field hospitals by the aid of the electric light.

"The whole modern development of electricity has taken place since the last great war, that between the Turks and Russians in 1878.

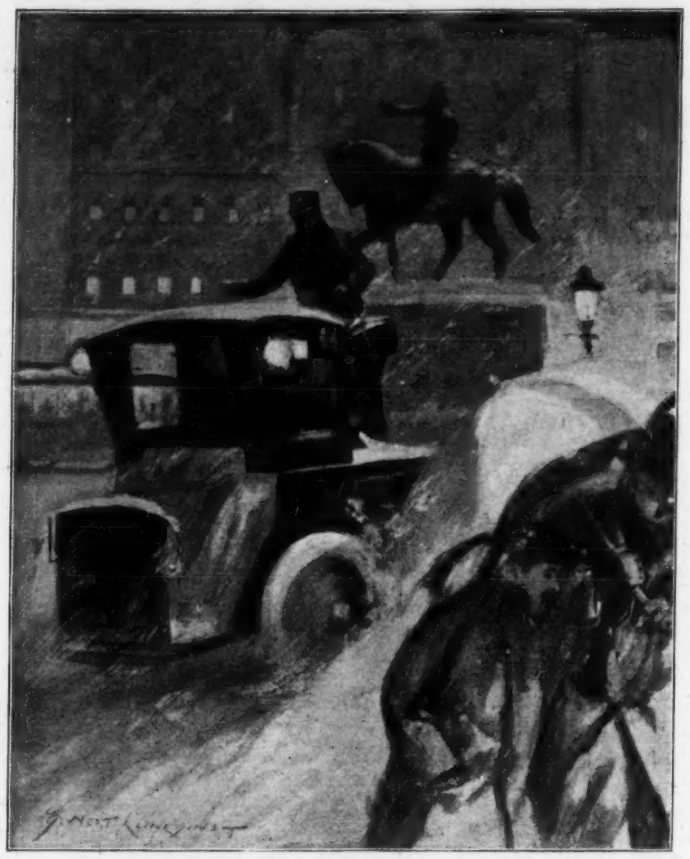
"In other branches of engineering great progress has been made. Modern high explosives are more powerful, easier and safer to handle, and, therefore, more useful for many purposes. The development in the use of nickel steel, Harveyized plates, and other forms of defensive armor for battleships would have been applied to modern sap rollers and trench defenses, and it is almost certain that the siege of Havana, under the conditions now existing, would have gone down to history as marking a new era in the art of war, a change from the old conditions brought about mainly by the engi-

neers. But it was not to be so. Cervera did not wait. He made his sally, was destroyed; Toral surrendered, and the war was over.

"We have had our experience, which I hope will not be without value to each and all of us, and which, I believe, has taught some useful lessons. It is my deliberate judgment that engineers, including tradesmen, will make better soldiers than any other class of men, and by soldiers I mean all that the word implies—men trained in drill and markmanship, able to care for themselves in the field, and to make long marches and to meet the enemy under all conditions, either offensively or defensively. The very nature of the training and daily lives of carpenters, blacksmiths, plumbers, lumbermen, railroad men, steam engineers, electricians' masons, etc., is a preparation for the life of the soldier. Moreover, we found that many of these men who had no intention of volunteering in the ordinary State regiments hastened to join an engineer regiment raised by the United States under a special act of Congress. This is another important fact that should not be forgotten."

Electrical Vehicles in the Recent Storm.

The recent severe snowstorm in New York city gave the first opportunity for observing the behavior under trying climatic conditions of the cabs and broughams operated by the Electric Vehicle Company. To the surprise of even some of their most staunch up-



A SCENE IN UNION SQUARE ON THE NIGHT OF NOVEMBER 26.

holders, the electric automobiles gave better service through the trying night of November 26 than did horse-drawn vehicles. The cabs ran through the whole night, the last coming in about 6 o'clock in the morning, by which time the snow had reached an average depth of about 8 inches, and much more where drifted. Other cab companies turned over orders to the electric service rather than fill them themselves. No very marked change in their running was noticed, although the mileage per charge of battery was as a precautionary measure greatly reduced, the vehicles being ordered in for fresh charges after covering ten or twelve miles. The ease with which they ran is probably due to the large pneumatic tires, 5 inches in diameter, with which they are fitted, which give a large bearing surface and reduce the tendency to cut deeply into the snow. The accompanying illustration is a reproduction of a drawing by B. West Clinedinst, made for "Leslie's Weekly," to illustrate this rather remarkable feature of the storm.

An Ampere Balance.*

BY PROF. W. E. AYRTON AND PROF. J. V. JONES.

The report of the Committee on Electrical Standards for 1897 ended with the following paragraph: "It thus appears to be a matter of urgent importance that a redetermination of the electrochemical equivalent of silver should be made, and that the general question of the absolute measurement of electric currents should be investigated. . . ." This work we were asked by the committee to carry out, and a grant of £75 was voted in its aid. We were thus led to examine into the methods which had been employed by Lord Rayleigh, Professor Mascart and others, for determining the absolute value of a current, as well as to consider some other methods which have not, as far as we know, been hitherto used.

After much consideration we decided to adopt a form of apparatus which, while generally resembling the type employed by some previous experimenters, possessed certain important differences, and, before expending any part of the grant of £75 to construct, without expense to the British Association, the following preliminary ampere balance:

On a vertical cylinder about 17 inches high and 6.8 inches in diameter we wound two coils, about 5 inches in height, separated by an axial distance of 5 inches. The coils consisted each of a *single* layer of about 170 convolutions of wire, and were wound in opposite directions. From the beam of a balance there was suspended, inside this cylinder, a light bobbin about 4 inches in diameter, on which was wound a coil about 10 inches long, consisting of a *single* layer of 360 convolutions, and the whole apparatus was so adjusted that when the beam of the balance was horizontal the inner and outer coils were coaxial and the top and bottom of the inner suspended coil were respectively in the mean planes of the outer stationary coils.

This arrangement was adopted because with coils consisting of only one layer the geometrical dimensions could be accurately determined, and because the shapes of the coils lent themselves to the use of the convenient formula, readily expressible in elliptic integrals, for the force, F, between a uniform cylindrical current sheet and a coaxial helix, viz:

$$F = \tau\, \tau_h\, (M_1 - M_2),$$

where τ is the current per unit length of the current sheet, τ_h the current in the helix, and M_1 and M_2 the coefficients of mutual induction of the helix and the circular ends of the current sheet.[1]

The value of a particular current of about 0.63 ampere having been determined *absolutely* by means of this apparatus, the rate at which it would deposit silver under specified conditions was ascertained indirectly by observing its silver value on a Kelvin balance, which had been kept screwed down in a fixed position for several years past, and which had been calibrated many times during that period by reference to the silver voltameter.

The result of this preliminary investigation showed that the silver value of the *true* ampere was so nearly equal to the reputed value, viz., 1.118 milligrammes per second, as to require the use of an apparatus still more perfectly constructed, and therefore of a much more expensive character to enable the error, if any, in this value to be ascertained with accuracy.

We, therefore, started on the design of the instrument, of which we now submit the working drawings, and for the future construction of which we would ask for a grant of £300, including the unexpended grant of £75 voted last year.[2] And we anticipate that this new piece of apparatus may prove worthy of constituting a national ampere balance, the counterpoise weight for which will be determined purely by calculations based on the dimensions of the instrument, the number of convolutions of wire in the three coils, and the value of the acceleration of gravity at the place where the instrument may be permanently set up. In this particular it will differ entirely from the "Board of Trade Ampere Standard, Verified 1894." which has had its counterpoise weight adjusted so that the beam is horizontal when a current passes through the instrument, which will deposit *exactly* 1.118 milligrammes of silver per second under specified conditions. In fact, the proposed ampere balance and the existing ampere standard will differ exactly in the same way as do a Lorenz apparatus and the "Board of Trade Ohm Standard, Verified 1894."

*Paper read before the British Association.
[1]Proceedings of the Royal Society, Vol. 63.
[2]This grant of £300 has since been made.

Practical Points in Street Railway Engineering. *

BY W. A. HARDING.

It was suggested to me that rather than present to you a paper full of data, etc., that I should call your attention to the different points of interest and problems that are met with in practical street railway work, so you could start a discussion and give to each other your personal experiences.

First, I must call your attention to the fact that it is impossible to make any arbitrary laws for the conduct and management of street railway property, conditions altering under various circumstances; financial conditions, condition of travel, nature of ground, locality, speed and climatic conditions, all require different managements and different problems to solve.

A road running through a very thickly populated district with good roads, etc., has the cost of operation at a minimum, and can afford to spend a few thousand dollars to raise low joints, put in plenty of feed wires and keep cars well painted.

But take a road running out far into the suburbs and sparsely settled districts; to put up feed wire, keep up voltage as it ought to be and to raise low joints would bankrupt the company, and as for painting cars, it is out of the question. Many a country road runs through marshy land, making low joints the rule. The mud and water may be thrown all over the cars, and if this is of an alkaline nature, you can easily see what becomes of your paint. Motors that under ordinary conditions are called water-tight will here fill with water unless extreme measures are taken to provide against it.

The choosing of a suitable car and equipment in the past consisted of buying car, truck and motor, without any reference as to their suitability to each other, and car or truck would have to be rebuilt to fit. I remember a company that bought long 36-foot combination cars, closed in the centre and open, with seats, at each end, having two massive four-wheel centre pivot trucks, and put in two 15-hp motors. Grades were from 3 to 12 per cent. It was only a short time before the motors were completely roasted. The company then went to the expense of cutting the body down to two-thirds size, taking one truck and lengthening out to 7 feet and putting in two 15-hp motors. The equipment now ran very satisfactorily, but owing to poor construction of the car body, they would "hog-back" in a very short time, necessitating constant renewals of subsills, etc.

Now what cars shall we use? Take a supposed case. For winter the public demands a five-minute schedule, and the average load is from twenty-five to thirty-five people, during rush hours say 100 people per load. We do not want to haul around a large car empty half the day, so we will put on a 22-foot car as large as is advisable for a single truck, with two motors and large and roomy platforms; if in a cold climate, preferably vestibuled. Now, if the cars should be a little crowded, the platform would always accommodate a few. When the rush comes on one or two trailers could be added for a few hours. If quickness and dispatch in unloading are not the predominating features, or too many transient passengers, a large double-truck trailer car is, in my mind, much the better. They are easier for motormen to handle than two single-truck cars, easier to ride, easier on the track joints, require one conductor in place of two, and can make much faster time.

During the summer the same rule applies, except that when the climate allows open ten-bench cars should replace the closed ones. If travel warrants it, there is still a better field for larger cars (which have side entrances) making less units.

Now, in the suburban districts sometimes the smaller cars will not accommodate your passengers, and yet you say you cannot afford to put on more cars. Now, you can use your large cars to advantage. In fact, you can sum up the whole problem as follows: Use the largest seating capacity cars that a satisfactory schedule will warrant. For suburban travel where speed is the main point, double trucks having four motors can be run faster than single trucks, with less wear and tear on equipment, track and passengers.

A word as to trucks. They should be built with the side bar in one piece, having no bolts or rivets, except where the cross braces for hanging brakes are placed. Brake shoes should not be hung on links, but in such a way that they cannot kick and will take up their own wear. An average wheel base of 8 feet is proper for single trucks when under a 22-foot closed body, or ten-seat open bench car. Springs should be graduated to allow the car to ride easily without undue oscillation. The same rule applies to tracks for double equipment, only the wheel base should be as short as the motor truck will allow, also allowing for the car to oscillate sideways.

The motors should be carefully chosen for the work to be done. A powerful motor, if put under a light car hauling trailer, will slip the wheels on the track and the car will not make sufficient speed; but if car body, trucks and motor are of sufficient weight to get the best traction, the train will now make faster time. The bearings of the armature should be large and fed from below with wick feed from oil with box above to hold wool waste with additional oil in place of the usual plan of dope. Such bearings should be built outside of the motor frame and also protected by large circular discs to prevent the oil from working into the motor.

The commutator should be made of good drop-forged copper bars, the diameter to be as large as possible. In G. E. 800 we use a bar 1½ inches high. By using soft amber mica between the bars the commutator wears smooth and keeps polished. The number of slots in the armature should be kept as low as possible, it being cheaper to make repairs when four to six coils can be put into one slot; also coils should be machine-wound, a thing not possible with all our armatures now.

A motor, if carefully kept clean, the brushes properly treated and changed each night and not abused unnecessarily by the crew, will last without rewinding for from four to five years, and even longer. With proper attention to brushes, commutators of the modern type should wear not more than one-eighth inch per year.

How are we to get the voltage raised at a distant point of the line where it is required for only a few weeks in a year? The cost to install a storage battery or booster, or to put up more wire, is all out of proportion to the returns. Take one of your dynamos with a capacity equal to the load demanded at this particular point. Change your two switches to double throw. When thrown up all connections are for running as a dynamo on the switchboard in the usual way. By throwing blades down, the + of machine is thrown onto an auxiliary bus bar and the — onto the positive main at the switchboard, making this particular dynamo in series with the station. The equalizing switch is left open; the field wires are not altered. The dynamo is now run at whatever voltage you need, may be 200 or 300. The feeder that goes out to the point of the line where you wish voltage raised is now thrown onto this booster, as we must now call it. Again, if the feeders are properly adjusted, a switch and fuse can be put in between the circuit breakers of several sections and a whole district raised in voltage, if only for a few hours during rush time. As the station usually holds a reserve unit, there is no additional outlay or expense needed. In case of a breakdown or disabled generating unit, the boosting would be discontinued until such time as repairs were made.

*Paper read before the Chicago Electrical Association, December 2, 1898.

That Aluminum Arc Lamp.

An announcement has been sent out to the trade by Mr. James Byrne, 95 High Holborn, London, that he has purchased English patent No. 23,138 of 1898, issued to Peter Spies, for the carbonless arc lamp, vague rumors of which have already reached this country. Another grain or two of information is contained in the circular, which reads as follows: "My arc lamp is simply an air-tight glass globe, from which the air has been exhausted. Inside are two L-shaped aluminum arms tipped with platinum, which take the place of the old-fashioned carbon, and are regulated by a pendulum. The lamp does not require to be suspended perpendicularly. In fact, it is intended to be fixed to project horizontally. It throws no shadows, and reduces the expenses of maintenance to a minimum. The wasting of the aluminum arms, owing to their being enclosed in the airless globe, is so small that only a yearly replacement becomes necessary."

Hoot Mon!

There is a proposal on foot for the utilization of an available water power in the Scottish Highlands, the scheme being promoted by the Highland Water Power Syndicate. The plan calls for an artificial waterway from Loch Ericht, near Dalwhinnie, via Loch Eilde Mòr and other lochs to Loch Leven, near Ballachulish. A head of 1100 feet will be obtained, which will be utilized in two falls of 550 feet each. With water also taken from another source it is expected that some 37,000 horse-power can be obtained.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE
AMERICAN AND FOREIGN
By Carl Hering.

Dynamos, Motors and Transformers.

ROTARY TRANSFORMERS. S. P. Thompson. Lond. "Elec. Eng.," "Elec." and "Elec. Rev.," Nov. 25.—The continuation of the reprint of his paper (see "Digest" last week). He describes briefly the device of Heldt for changing the awkward percentage numbers which exist between the voltages of the two sides of such a converter; he introduces a second ring around which the alternating currents flow in passing from the armature to the collecting brushes, and in these windings the alternating voltage is brought up from 70.7 to 100, thus making the voltages of the continuous and alternating currents alike. This is equivalent to using a mixed star and delta winding, the latter constituting the true converter winding. Another solution exists in altering the distribution or concentration of the magnetic field at the poles, as any concentration of the field will alter the conversion ratio; a machine of this kind is described and illustrated. He then quotes from Kapp's recent paper on the question of the influence of changes in the distribution of the flux on the conversion ratio and on the efficiency; also from his treatment of the question of the limit of output for equal heating, different pole breadths and different angles of phase displacement.

FREQUENCY AND EFFICIENCY OF TRANSFORMERS. —Lond. "Elec. Eng.," Nov. 25.—Answers to the question, what difference is made in the efficiency of a transformer by raising the frequency from 50 to 100?

BRAKING INDUCTION MOTORS. Eichberg. "Elek. Zeit.," Nov. 24.—A long article in which he discusses the braking action of such motors, with special reference to its application for traction purposes. There are two conditions when the multiphase induction motor will absorb mechanical energy; the first is an oversynchronous speed and the other a counter rotation of the armature against the field. The condition of the braking is, either that the number of revolutions of the motor is greater than the number of revolutions of the field, or that the latter is negative compared to the former; the first is accomplished by reducing the number of revolutions of the field—that is, by reducing the frequency or increasing the number of poles; the second condition is fulfilled by changing the direction of revolution of the field. It is therefore possible to brake in three different ways—to excite by a current of a lower frequency; to increase the number of poles per phase; to reverse the direction of the revolving field by changing the connections; several of these may be combined. The braking is not equivalent in all these cases. He then discusses them mathematically at considerable length, giving formulas for the braking action, efficiency, etc.; in the first and second case the braking action will be a useful one, as the work performed is given off externally; the motor becomes a generator; but it is quite different in the third case, in which the braking energy is set free in the armature, heating it. In his discussion he shows a number of diagrams from which it is possible by direct reading and some calculation to find the efficiency, the duration of the braking action and the amount of energy returned. (For another article on a similar subject see "Digest" last week.)

STARTING AND REGULATING MOTORS. Guilbert. "L'Eclairage Elec.," Nov. 19.—Illustrated descriptions taken from patent specifications. The method of Egger, which was described some time ago in a German journal, is fully described with the aid of a number of diagrams.

Lights and Lighting.

ALLEGED REVOLUTION IN ARC LAMPS.—"Elek. Anz.," Nov. 24.—A note taken from an English daily paper on the new form of lamp devised by Spies. These lamps are claimed to require no recarboning and no other attention for a period of twelve months, except an occasional cleaning; they contain no mechanism like that of the usual arc lamp. The lamp consists of a glass vacuum bulb which contains two L-shaped arms of aluminum provided with platinum points, which are "regulated by a pendulum," and which are said to take the place of the usual carbons; the lamp need not be vertical; it throws no shadow, and the consumption of the aluminum arms is so slight that they need be renewed only once a year. No further details are given.

ELECTRIC FOUNTAIN. Levy. "El'ty," Dec. 7.—A reprint of a short, illustrated article on electric fountains, with special reference to the one in the Brooklyn park.

Power.

TRANSMISSION OF POWER. Forbes. Lond. "Elec.," Nov. 25.—A brief editorial mention of a recent Society of Arts paper, referring to his "simple financial transactions which copper merchants or others would willingly make, and which may avoid the huge capital hitherto required by those who transmit the power, and will increase the dividends on moneys spent on transmission"; in an example the net income is shown to be increased from 9 to 40 per cent. The financial scheme referred to is that the capital should be divided into two parts, the major part, represented by copper, is a 4 per cent. mortgage on the transmission line, while the smaller part, spent on hydraulic and electric machinery, will then produce a net income equal to 40 per cent. of this part of the capital after the interest on the mortgage has been paid. Editorially it is thought that this scheme is like the one known as "robbing Peter to pay Paul," with an element of uncertainty as to who is Peter and who is Paul.

TRANSMISSION OF POWER. Siemens. "El'ty," Dec. 7.—The beginning of a reprint of his Brit. Assn. paper which was noticed in the "Digest" Oct. 15.

POWER TRANSMISSION FOR MINING. Esson. "Eng. and Min. Jour.," Dec. 3; and "El'ty," Dec. 7.—A reprint of the abstract of his paper noticed in the "Digest" last week.

CRANES.—"El'ty," Dec. 7.—A reprint, without the illustrations, of the article noticed in the "Digest" last week.

SHOREDITCH DESTRUCTOR PLANT.—"El'ty," Dec. 7.—Extracts from the recent reports published in the English papers.

Traction.

ELECTRICITY FOR HEAVY RAILROAD WORK.—"Elek. Anz.," Nov. 20; abstracted from "L'Elettricita."—A brief description of the project of Ganz & Co. for the line from Lecco to Sondrio and Chiavenna, Italy, a distance of 63.6 miles, including grades of 2 per cent. In an introduction the advantages of the multiphase motors for such lines are pointed out: they are more simple to operate, involve a cheaper installation and permit of a simple reduction of the voltage with stationary transformers; the question of the voltage is the deciding one in the application of electricity on railroads. It has been shown that alternating currents are dangerous at a much lower voltage than is generally supposed, and therefore installations at 2,000 to 3,000 volts should not be considered under a different category than those for 400 and 500 volts which are in daily use. The present line will be for both passengers and freight; at times of dense traffic the number of trains will be increased, instead of the number of cars per train. The passenger trains will have a maximum weight of 65 tons, consisting of a motor-car and one or two trailers; the freight trains will be drawn by a motor-car with a pull of 5000 kg, and can have a weight of 200 tons; the speed of the passenger trains will vary between 36 and 18 miles an hour, and of the freight trains between 18 and 9 miles. A motor-car will have four motors, two of which will operate continuously; the high-voltage current will pass through the stationary field; the two other motors are only used when the speed is to be reduced to one-half, in which case the movable armatures will be supplied from the first two motors, the regulating resistance being inserted in the stationary winding of the second motors; with this system only low-voltage currents will be used for regulating the speed. There are no more difficulties in the installation of such motors than there are with the usual transformers. The primary voltage is to be 15,000 and the voltage on the trolley wires 3000; by a special method not described the wire will be disconnected in case it breaks. Soldering of the wires is not permitted, as all junctions must be made with metallic couples. The current is taken from the wires by means of two rollers on the end of an insulated pole; these are made of aluminum, and have a width and length of about 60 cm; both are held "at their ends by a rectangle" with which are connected two systems of spring contacts for making connections with the line; the first has a tension of 100 kg for high speeds and the other of 10 kg for low speeds. At crossings the wires are on a different level, and the current is broken at the crossings itself. There is a set of trolley wires at each end of the current. The current is generated directly by hydraulic power, at 15,000 volts by means of seventeen alternators in three groups, each of 2000 horse-power maximum, one group acting as reserve.

ELECTRIC RAILWAYS IN AUSTRIA.—"Zeit. fuer Elek.," Nov. 20.—A table for the third quarter of this year, showing the operation of the electric railways in Austria and Hungary.

LIVERPOOL MOTOR VEHICLE TRIALS.—Lond. "Elec. Eng.," Nov. 25.—A mention of the judges' report referring to the trials of last August; it forms a volume of 150 pages in which full details and illustrations are given. The conclusions are reprinted in that notice.

SOME ELEVATED RAILWAY PROBLEMS AND RESULTS.—"St. Ry. Jour.," Dec.—A presentation of the results of electric railway operation in Chicago in comparison with steam elevated railway operation in New York city. The article is fully illustrated with diagrams showing acceleration, speed, distance and power curves, plotted from actual runs on the South Side, Lake Street and Metropolitan elevated railways of Chicago, which, it is

claimed, were never before published. The influence of speed upon gross receipts, and of rapid acceleration upon schedule speeds of different systems of motive power, are carefully discussed, and the comparative economy of steam and electricity in this character of service are set forth at length. It is shown that the Manhattan Elevated Railway Company, of New York, could nearly double its present rate of earning power upon both old and new investment should it adopt electricity as a motive power. A description of the Sprague multiple unit system as used in Chicago is given, and it is shown that this system has large possibilities.

SOME FALLACIES REGARDING ELECTROLYSIS. Herrick. "St. R'y Jour.," Dec.—He claims that the danger to water-pipes and other subterranean conductors by the return current is greatly exaggerated, and can always be prevented by proper methods. He first discusses the general subject of electrolysis, and shows that the effect of the flow of current from rails to water-pipes is not to deposit the metal of the rails upon the pipes, but upon the ground adjacent to the rails. This deposit is an iron oxide, which has a high resistance, and its immediate effect is to increase the resistance of the space between the rails and the water-pipes. Potential measurements are therefore not a criterion of electrolysis destruction. Nitrogen is also generated at the water-pipes, and its presence tends to preserve their surface. On the other hand, the flow of current through the soil increases the capillary activity of the latter, attracting water, and so lowers the resistance to a certain extent. As each case requires special consideration, he describes a method of making preliminary tests. He discusses the method for measuring the current flow in a water-pipe, that from the rail to the water-pipes at any point, and the relative value of the rails as return conductors. One method employed to reduce electrolysis is to connect the water-pipes and ground return with a common return feeder of low resistance, and where this is done properly it is a satisfactory solution of the question. Another solution under proper conditions is to introduce insulating "rust" joints in the water-pipes. Electrolysis of lead-covered underground cables can be prevented by connecting their covering to the station by a metallic return.

SURFACE CONTACT SYSTEM AT MONACO.—"Elec. Eng.," Dec. 8.—A brief, illustrated description of this short line, extending from that city to Monte Carlo. The original plans were prepared by the General Electric Company, of this country. The gauge is 3 feet 3 inches; the cars carry thirty-six passengers each; there are six cars in operation at present; the road is 3 miles long, and will ultimately be increased to 6 miles. The contact studs are placed in two parallel rows between the rails, alternating in their position; each of the negative or low-potential series on one side is connected, through a solenoid, to the rails, which form the return circuit; the positive or high potential series on the other side transmits the current from the feeders to the motors; the automatic switches are placed in large chambers containing twenty-two switches, each of which consists of a solenoid, which moves a soft iron core, which actuates an iron plate, carrying three pieces of carbon for making the contacts. A small battery on the car sends a current through the low-potential studs to the rail, through the solenoids, and this energizes them and operates the switches connecting the feeder with the high-potential studs, after which the battery is cut out as the return current serves to energize the magnet. The connections between the cars and the studs are made as usual with long shoes. The studs are 16 feet apart; each switch chamber works forty-five studs, extending over a length of 218 feet; a 500-volt current is used.

CONDUIT CONSTRUCTION.—"St. R'y Jour.," Dec.—The Third Avenue Railway Company, of New York, will install immediately 73.66 miles of electric conduit track, of which 28.5 miles are being operated by cable and 45.16 by horses. On the main Third Avenue cable line the present conduit will be utilized; the One Hundred and Twenty-fifth Street and Tenth Avenue cable line, however, is quite old and will be removed. The construction adopted here and for the new work differs radically from anything heretofore installed. The chief feature of the novelty is in the employment under the track rails of a creosoted yellow-pine timber, 5½ inches wide, 6 inches high, and laid in 30-foot lengths, the object of which is to secure an easy-riding track. The yokes on the new construction are spaced 5 feet apart, and are made up of three pieces, riveted together, viz., a steel I-beam and two cast-iron side pieces; the yokes rest on a concrete bed, 4 inches in thickness; the track rail is laid in 60-foot lengths, is 9 inches high, and weighs about 107 pounds. The insulators and conductors are of the same type as used elsewhere in New York. Where the present cable conduit is retained a 7-inch rail will be used, as no change can be made in the yokes. The rail weighs 104 pounds, and the joints are cast-welded. Where the base of each rail rests on the yoke a spring is employed to give an easy-riding track. It is estimated that 3600 wheels pass over a given spot on this line in twenty-four hours, and that the weight of each wheel is 6375 pounds. The article is fully illustrated, showing also a special type of convertible car which will be employed.

THE BLACKPOOL ELECTRIC TRAMWAY SYSTEM.—"St. R'y Jour.," International Edition, Dec.—This is a short line, built in 1885, and employs an underground conduit, views of which are given in the article. Considerable difficulty has been experienced with the conduit choking up with sand and water, and as the road is near the sea it is difficult to keep the conductors free from a saline deposit which causes large leakage of current. The company has therefore decided to abandon the conduit system in favor of the trolley system.

THE GLASGOW CORPORATION TRAMWAY.—"St. R'y Jour.," International Edition, Dec.—A fuller description is given of the engines and cars of the Glasgow Corporation, of which a general article was published last month. The engines are of the compound type, and each drives a 200-kw generator. The cars are for the most part single deck and double truck, with a seating capacity of fifty. The lower frame of the car is of steel and the upper framing of ash, with mahogany panels.

THE UNION ELEVATED RAILWAY OF CHICAGO.—"St. Ry. Jour.," Dec.—An extended description with engravings and plans of this power station.

RAILWAY BETWEEN ANDERSON AND MARION, IND.—"St. R'y Jour.," Dec.—This system embraces 80 km and connects a number of the towns in the natural gas belt region. A number of views are given.

TRAMWAYS IN FRANCE.—"St. Ry. Jour.," Dec.—A tabulation from the "Zeit. f. Kleinbahnen" of the French tramways operated by mechanical and animal power, and the gauges employed.

Installations, Systems and Appliances.

SHUNT DYNAMOS IN PARALLEL. Philip. Lond. "Elec.," Nov. 25.—A short article referring more particularly to the explanation of the recent breakdown at Brighton. As is well known, special precautions must be taken when shunt machines of different designs are run in parallel, in order that the e. m. fs. of all the machines (he no doubt means the difference of potential) may fall and rise at the same rate when the load varies; if the adjustments are not made very well, a large increase of load may cause the distribution of it to vary so greatly that some of the dynamos may become motors. A sudden drop in voltage on the bus bars may be due to four causes—by decreasing the resistance between the bus bars, by the breaking of a shunt circuit, by a short circuit in the armature, and by suddenly switching out one dynamo which carried a large part of the load. Each of these is discussed. He supposes in an illustration that there is a short circuit outside of the brushes, but inside of the minimum cut-outs at the bus bars; the armature would then act like the primary of a step-up transformer, of which the shunt windings form the secondary; "the e. m. f. thus set up in the shunt would act so as to lower the potential across the mains, or even possibly reverse it"; it should also increase the armature current of the other machines and weaken their shunt circuits. In order to test the magnitude of this effect he made an experiment with a hedgehog transformer and a battery in connection with a dynamo, and the results show that there is no doubt that the kind of action predicted takes place, although its magnitude in the experiment was but slight. The sudden removing of the armature from the circuit by means of the minimum cut-outs would by itself cause a drop in the bars, and the two effects together may account for the other similar dynamos cutting out, leaving the other two alone on the bars. If the accident at Brighton was not due to a short circuit of the bus bars, but is accounted for by the above facts, the fluctuation in a dynamo's field appears to follow the alteration of the exciting current more rapidly than one would expect.

VOLTAGE REGULATOR IN THREE-WIRE SYSTEM. Del Proposto. "Elek. Anz.," Nov. 24.—The beginning of a translation in abstract of the article noticed in the "Digest" Nov. 26.

SWITCH FOR ACCUMULATORS.—"L'Eclairage Elec.," Nov. 19.—A brief, illustrated description of a method for switching in and out accumulators as the voltage of the charging dynamo rises or falls; the device is made by Guenee & Co.

ELECTRICITY ON A VESSEL.—"L'Elec.," Nov. 26.—A brief description of the electrical equipment of the German steamer Aegir, the electrical equipment of which is said to be very complete.

GAS ENGINE LIGHTING PLANT.—"Elec. Eng.," Dec. 8.—A brief description of the plant in the French Chamber of Deputies in Paris, which is a very large gas engine plant supplying 4610 lamps. A fuller description in a foreign journal was recently referred to in the "Digest."

Wires, Wiring and Conduits.

FIXTURES.—Lond. "Elec. Eng.," Nov. 25.—Reproductions of illustrations of ornamental electroliers from the catalogue of the English General Electric Company.

Electro-Physics and Magnetism.

POLARIZATION AND DISPERSION. Becquerel. "L'Eclairage Elec.," Nov. 19.—A long abstract of an Academy paper on rotary magnetic polarization and abnormal dispersion, with special reference to the new experiment of Macaluso and Corbino.

TOTAL REFLECTION OF ELECTRIC RADIATION. Bose. Lond. "Elec.," Nov. 25.—A reprint of a recent Royal Society paper on the influence of the thickness of air space on total reflection of electric radiation.

COMPONENTS OF HARMONIC WAVES. Stern. "Elek. Zeit.," Nov. 24.—A short article calling attention to an error of a sign in the article by Houston and Kennelly in The Elec. World, May 14, on "A Simple Approximate Method of Determining the Harmonic Components of a Graphically Given Complex Harmonic Wave." He praises the method, but states that this error may give rise to others. A suggestion is also made of a modification which would give the result more quickly.

ALTERNATING-CURRENT CALCULATIONS. Lyle. Lond.

"Elec.," Nov. 25.—The conclusion of his long serial (see "Digest," Dec. 3). He continues the solution of a number of problems to illustrate his method of making such calculations.

CONTINUOUS CURRENT IN THE ALTERNATING ARC. Eichberg and Kallir. "Zeit. fuer Elek.," Nov. 20.—The beginning of a long abstract of the paper noticed in the "Digest" Nov. 5.

RESEARCH LABORATORY.—Lond. "Elec. Rev.," Nov. 25.—A long editorial on the engineering research laboratory in its relation to the public.

EARTH CURRENTS AND EARTH'S MAGNETISM. Weinstein. "Elek. Zeit.," Nov. 24.—An abstract of a recent paper giving the results of scientific research which has been carried out in Germany. These researches appear to have been very extended, and the present report is in the nature of a summary of the results. The number of records of earth currents which were recorded amounted to more than 2000, and of the earth's magnetism to more than 5000. Some rather interesting polar curves are reproduced, showing the daily horizontal variations in the earth current for four years, and another, their mean; these all show a characteristic similarity. In both intensity and direction of the earth current there was found to be a remarkable regularity of the variations during the day; it is greatest about noon and least at night, but it varies in a wave-like way, and there is a peculiar reversal; the irregularity is greater at night than during the day, and the currents vary in such a way that the curve forms a loop. The current also varies with the seasons of the year, decreasing constantly from November to December, increasing again rapidly from January to February, and remaining nearly constant during the rest of the year. Curves drawn for a large number of years all show the same form, even in the finer details; it is only in the amplitude of the variations that there are changes. This goes to show that it is a natural phenomenon. The results seem to show that the earth currents are not an induction action of the variations in the earth's magnetism; also that the greater disturbances in the earth's current appear to be the cause of the movement of the magnetometer.

MODERN THEORY OF MAGNETISM. DuBois. "Elek. Zeit.," Nov. 24.—An article discussing the mathematical theory, based chiefly on that proposed by Hopkinson. It is of a highly mathematical character, and is illustrated with an example.

Electro-Chemistry and Batteries.

CHLORATE WORKS. J. B. C. Kershaw. Lond. "Elec. Rev.," Nov. 25.—A brief, illustrated description of the works in the southeast of France, where over 10,000 horse-power furnished by a water power is used for the manufacture of chlorate of potash, aluminum and calcium carbide; 3000 to 4000 horse-power are used in the manufacture of chlorates of potassium and sodium by the Gall and Montlaur process, which in principle is the old process of Watt patented in 1851. A solution of an alkali metal chloride is electrolyzed between insoluble anodes at a moderately high temperature and the less soluble chlorate salt, formed by the reaction between the free chlorine at the anode and the caustic alkali formed at the cathode, is separated by crystallization. The anodes are of an alloy of platinum and iridium, containing 90 per cent. of the former, as this stands the action of chlorine better than the pure platinum; the cathodes are of an iron-nickel alloy and are covered with an asbestos cloth to carry off the hydrogen, of which 19,000 cubic feet are produced for each ton of chlorate obtained. The details of the process are kept secret; the current density is said to be 465 amperes (but for what area is not stated). No external heat is required, as the current keeps the mass at a sufficiently high temperature; the presence of metallic oxides must be carefully avoided, as they decompose the product; the latter requires re-crystallization before it is ready for the market. In addition to these works at St. Michel the same company has a chlorate factory at Vallorbes, in Switzerland, where 3000 horse-power is used, the two works together producing 1800 tons of chlorate per annum. At first the output per electrical horse-power day was only 1 kg in place of 2.69 required by theory, but the yield has now been considerably increased. No details of cost are given, but he assumes that 1 pound could be produced for 5.5 cents; the selling price, however, has become lower, thus narrowing the former good profit; the outlook is said to be rather gloomy, as the number of these electrolytic plants is increasing. Two good photographs of the plant at St. Michel are given.

TREATING REFRACTORY ORES.—Lond. "Elec. Rev.," Nov. 25.—A brief, illustrated article on the Cowper-Coles electrolytic cyclic process for the treatment of refractory ores. A former description having already been given, the present article only points out some further details. Zinc from the sulphate solution is deposited on aluminum plates, which greatly facilitates the stripping of the zinc. The deposit is intentionally a zinc sponge, which forms a good substitute of what is known as zinc dust, and is used among other things for his regenerative electro-zincing process; an analysis of this zinc dust is given; to ensure the deposit in the form of sponge a low density of current and a weak solution are used. The lead obtained by the leaching with caustic soda is deposited on revolving discs and scraped off; it is very pure; an analysis is given. The apparatus for producing white lead from the sodium plumbate solution obtained by the leaching is shown. The silver is leached out from the ore with cyanide of potassium, from which it is then deposited on to silver sheets. The white lead is precipitated with carbon dioxide, which is produced from calcium carbonate by passing through water the sulphurous acid given off from the roasting, this acid being used to drive off the carbon dioxide from the calcium carbonate; the gases are passed through the lead solution and precipitated as sulphide, and the carbon dioxide, thus purified, is then passed through another cylinder, where lead carbonate is precipitated. Litharge is also made from the plumbate solution by evaporating it. More details are promised. A short summary of some of the inventor's conclusions from the commercial experiments in New South Wales are given briefly in the "Eng. and Min. Jour." (N. Y.), Dec. 3.

CALCIUM CARBIDE. Nicolai. Lond. "Elec. Eng.," Nov. 25.—A very brief abstract of a recent German paper. He states that the best proportions of the mixture is 100 parts by weight of lime to 70 of coke; lime averaging 99 per cent. of calcium and coke which is low in ash will produce an almost pure carbide; the coke should not run higher in ash than 5 per cent.; charcoal is unsuitable in the furnace process, but in the smelting machine invented by him it can be used, for in this the material to be smelted is compressed on to a conductor of a suitable height, and the arc touches the compressed mass only at the moment of smelting. In the manufacture of the carbide care should be taken that the raw material is not burnt by the hot gas, as is often the case in the electric furnace, so that the loss in electric power may be reduced to a minimum; the raw material should be exposed to the arc only as long as is necessary for its conversion into the carbide.

ALUMINUM.—Lond. "Elec. Rev.," Nov. 25.—A short abstract of a recent paper by Ristori, in which he described the Milton works and discusses the working of this metal, which at first presented so many difficulties; these have now to a very large extent been surmounted. The principal uses of aluminum are also discussed.

CALCULATED VOLTAGE OF ACCUMULATOR. Fitz-Gerald. Lond. "Elec. Eng.," Nov. 25.—A discussion of the relation between the volts and the calories in a lead accumulator. The voltage might be calculated from the calories as in the ordinary battery, and the question arises whether that application to the accumulator is approximately true or fundamentally false. In a Daniell cell the number of calories generated is about 46,000 per volt, and therefore it should be 92,000 per dyad-gram equivalent in the lead accumulator. He quotes S. P. Thompson, who discusses the various hypotheses explaining the chemical action in accumulators, of which he mentions five, and discusses their relative correctness, concluding that he thinks that the last one is the real action in the cells, this last one being that the peroxide is changed to monoxide, and that the spongy lead also becomes litharge. Fitz-Gerald also quotes from Treadwell's recent book, which he praises very highly, but criticises the quotation. Thomson's law is briefly explained. He maintains in opposition to the general consensus that in the case in which the e. m. f. is not constant, but falls from a maximum to a minimum, Thomson's formula will give the mean e. m. f. and not the minimum or the maximum. In the case of the accumulator the fact that the calculated value is 2 volts is a proof that the assumed reactions and their calorific values are incorrect and inapplicable.

ACCUMULATORS FOR AUTOMOBILES. Reyval. "L'Eclairage Elec.," Nov. 19.—An illustrated description, with tabulated data, of the Fulmen accumulator, which is used largely on French automobiles. Its special features are great power per pound and great storing capacity per pound. The plates appear to be mere modifications of the old form of grid accumulators, the meshes being rather large, and the amount of active material, therefore, relatively great. A table gives the various data for a five-hour discharge; some curves of the discharge are also given.

ELECTROCHEMICAL SOCIETY. Muller. "L'Eclairage Elec.," Nov. 19.—The continuation of the account of the proceedings of the congress at Leipsic.

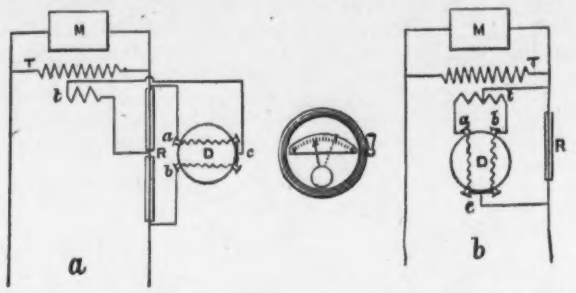
THERMO-ELECTRIC AND GALVANIC ACTIONS. Reed. "Jour. Frank. Inst.," Dec.—A reprint of an interesting paper read before that institute defining and comparing these two actions. The two processes are of an entirely different nature, but the electrochemical one can never take place without being accompanied and modified by the thermo-electric process, while the latter may take place without any chemical action; in another kind of apparatus the thermo-electric process is always accompanied by chemical change; this concurrence of the two, which is due to the nature of the materials, has given rise to difference of opinion as to whether the action in a particular case is electrochemical or thermo-electric. He then discusses certain actions which have been subject to this confusion. He defines what is meant by each of the two actions, starting with the premise that no body or system can be the origin of energy or of any process evolving energy unless in its final state its energy is less than in its initial state. The Peltier and the Thomson effects are described and discussed at some length, both analytically and graphically; the existence of these effects in electrolytes has been conclusively established. Galvanic action is then defined; it always necessitates the following conditions: The chemicals must be electric conductors and form part of the circuit; at least one of the conductors must be a compound and an electrolyte; the chemical reaction must evolve energy; a further condition seems to be that the electrolyte shall not be a single compound, but a solution of one compound in another. The two laws governing such actions—namely, Faraday's and Thomson's—are then described. When electrical energy is evolved without the application of heat there is no doubt that it is evolved as the result of chemical change, and if no heat enters or leaves during the process, and no change of temperature occurs, the chemical action is the only source of the energy;

but when this electrical energy is evolved only during the application of heat and when the chemical state is identical at the beginning and end, the electrical energy must come solely from the heat absorbed, and the process is then thermo-electric. The initial and final chemical state may be different, and yet the process be entirely thermo-electric; this occurs when heat is applied and electrical energy evolved, and when the final chemical state involves more energy than the initial. Illustrations are given; in one of these two iron electrodes are placed in fused alkali hydrate and at 500° to 700° the voltage may be as high as 1.2. In another case a silver crucible formed one electrode, a carbon rod the other and fused sodium hydrate the electrolyte, heat being applied, and a current of air was blown into the electrolyte; the carbon rod was oxydized and metallic sodium was reduced; the Jacques cell differs only in the substitution of an iron vessel for the silver cup. The e. m. f. required for dissolving and depositing the same metal may be very minute and may be generated thermo-electrically within the cell by raising the temperature of one electrode above that of the other, as, for instance, by making one electrode a tube through which a stream of hot or cold water is passed; copper is then deposited from a sulphate solution on the hot electrode and dissolved from the cold, the two electrodes being connected with each other. Another interesting illustration of a thermo-electric action was an experiment in which a zinc tray containing a strong solution of zinc chloride is heated; when a copper strip is introduced it will be covered with a smooth, perfect deposit of zinc as soon as the copper is in contact with the tray; iron or other metal which is not dissolved by the solution may be plated in this way. The initial and final chemical states are identical and the action is thermo-electric; the metallic strip is at a lower temperature than the tray, since it receives its heat only from the electrolyte, which in turn receives it from the tray, the junction of the electrolyte with the tray being necessarily hotter than its junction with the copper strip; the e. m. f. is several tenths of a volt. A similar action takes place with sulphate of zinc, although the deposit is obtained only with difficulty; the e. m. f. is about 0.6 volt, and tends to deposit zinc on the copper. In the discussion Kennelly pointed out that it was difficult to determine whether a cell belongs to one type or to the other, as every voltaic cell is always accompanied by thermo-electric action, and every thermo-electric cell containing an electrolyte is accompanied by electrolytic action, the two being in some cases blended together; one element heated to a higher energy than another might then be endowed with chemical affinity for the electrolyte by virtue of the heat received. A thermo-electric action is limited in its efficiency of transformation by the range of temperatures employed, according to the well-known laws of thermo-dynamics, whereas with voltaic action an efficiency of 100 per cent. is possible; if, therefore, the losses of energy in the cell could be measured it might become possible to determine whether the action is thermic or chemical. He therefore thinks it cannot be demonstrated which it is, without experimental observation. Richards did not accept Reed's conclusions regarding the thermo-electric character of the Jacques cell; he claims that there is no difference of temperature, as all the parts are heated to the same degree, and therefore there can be no thermo-electric action, for which reason the current must be due to chemical action. There is, on the other hand, abundant material for supplying a chemical explanation of the action; carbon, for instance, will reduce fused caustic soda. In making calculations it would be necessary to know the heats of formation at those high temperatures. Reed, in his reply, admits the application of the thermo-dynamic law and claims that the conversion of heat into chemical energy by absorption, or into any other higher form by any other process, must come under the same limits. There is no necessity for a new theory to account for something that is not known to exist. He claims that there is a difference of temperature between the different parts of the Jacques cell, as heat is received at about 800° C. and rejected at about 300°. With regard to his illustration of the thermo-electric cell he states that it was understood that the heat be applied so as to produce unequal temperatures. There is no surplus energy in the action of carbon when it reduces sodium hydrate, except the superfluous heat of the furnace, as this reaction absorbs energy, and does not set it free. The only energy that can originate in a system, therefore, is that which it contains before any external heat is applied.

ELECTRO-DEPOSITION OF COPPER.—"Elec. Rev.," Dec. 7.—A reprint of the article noticed in the "Digest" Nov. 12.

Units, Measurements and Instruments.

HOT WIRE AMPERE-VOLT-WATT-METER. Field. Lond. "Elec. Rev.," Nov. 25.—The beginning of a description, with the theory, of an instrument devised by him. It might be called a two-voltmeter method, as the watts are given by the difference of the squares of two-voltmeter readings. The voltages are reduced to a very low figure, so that the amount of energy consumed is small; there are no disturbing effects by hysteresis, Foucault currents, self-induction, capacity, or neighboring conductors carrying currents; the instrument is for use in testing rooms and laboratories, and can be used for determining the current, voltage, power and power factor. The two needles, operated by the hot wire, move over the same scale; by means of a clamp they are held in position while a reading is being taken, at the same time both hot wires become shunted so that the mechanism can return to nearly the zero position; the instrument is absolutely dead beat; in the main circuit there is a known inductive resistance which will give a drop of 1.5 volts with the maximum current; a transformer reduces the voltage to be measured. There are two ways of connecting, one is to divide the non-inductive resistance and the other is to divide the secondary winding of the transformer into two different parts; the current in one of the halves in either case passes through the whole of the other before passing through the corresponding hot wire, as shown in the adjoining figures. The voltage which exists between the



branches *a c*, *b c*, then corresponds to the vector sum and difference respectively of the different e. m. fs. which represent the main current and the supply e. m. f. If the instrument is calibrated to indicate directly the mean square value of the potential difference, then the difference between the two indications will be a measure of the watts. By means of a switch the connections may be changed, so that one needle measures the current and the other the voltage, thus enabling the lag of the current to be determined; the scale is very nearly a square root scale, and therefore if graduated to indicate the square, an almost equi-proportional scale is obtained. The very small self-induction of the branches are of no account; in his theoretical discussion which follows he assumes self-induction in all the branches in order to compare the results with those from a two-coil wattmeter.

PREPAYMENT METER.—Lond. "Elec.," "Elec. Rev." and "Elec. Eng.," Nov. 25, and "Lightning," Nov. 24.—An illustrated description of the Long-Schattner meter, into which coins are placed, which will enable a corresponding amount of current to be used. It is an electrolytic meter similar to the old Edison type, except that copper is used instead of zinc, the solution being copper sulphate. A balanced arm contains trays on to which the coins are dropped; their weight tilts the beam which operates the meter by means of two mercury cups; when the corresponding amount of copper has been dissolved from the anode, which is supported by the end of the beam, the latter will rise again; this latter movement switches the main current through a rather large resistance, which reduces the brilliancy of the lights without, however, extinguishing them, thus giving notice that another coin must be added; the current flowing at that time is also measured in the meter, and is paid for by the coin which is subsequently put into the meter. The electrolytic cell is shunted by a resistance, so that only a definite portion of the current is measured; the object of the mercury cups is merely to short-circuit the resistance through which the main current passes when there are not sufficient coins in the box. The mercury cups are covered with creosote, and the make and break is said to be perfectly sparkless. One copper plate and box will last for 700 kw hours. A thin layer of machine oil is poured over the top of the solution to prevent its evaporation. The meter is adapted for silver coins, and not for those of copper. It is the copper which is dissolved, and not that which is deposited, which operates the beam; the current is led in at the top of the plate and out at the bottom of the copper box, thus giving an even distribution of the current; there is such a low density of current that there is no heating and no gas evolved; the loss of volts across the meter is only 0.2 for 5 amperes at 220 volts, or half this for 110 volts.

PHASE METER. Aliamet and Brunswick. "L'Elec.," Nov. 26.—An illustrated description of the Bruger instrument which was referred to in the "Digest" July 16 and Aug. 6. It consists of two coils fastened together perpendicularly to each other, and suspended so as to move as a whole; through one of these passes a current whose phase is not shifted, while through the other passes a current whose phase is shifted through 90°; this double coil is suspended between two fixed coils through which the current whose phase angle is to be determined passes; the deflection of the movable coil will then be equal to the phase-shifting between the current and the voltage; the sign of the angle will be determined by the direction of the deflection. The two currents in the movable coil between which the phase angle must be 90° are obtained by having one coil in series with the primary of the transformer, and the other coil in series with the secondary. The theory of the instrument is given briefly.

IRON-CONSTANTAN THERMO-COUPLES. Van Aubel. "Arch. Sc. Phys. Nat.," Geneva, 103, p. 4; noticed briefly in Lond. "Elec.," Nov. 25.—An account of the researches by a number of physicists in the use of thermo-couples of this kind for measuring radiant heat; Kleiner found that the temperature curve is very nearly a straight line; Van Aubel used it for determining the thermal conductivities of various alloys.

DETERMINATION OF DIELECTRIC CONSTANTS. Erskine. "Wied. Ann.," No. 10; abstracted briefly in Lond. "Elec.," Nov. 25.—If K and k are capacities inserted in a primary and secondary circuit, and C and c the respective currents, he proves that c changes very rapidly with k when K has certain values; hence with a suitable current indicator the mutual influence of the two circuits may be used for comparing two capacities with great accuracy, and

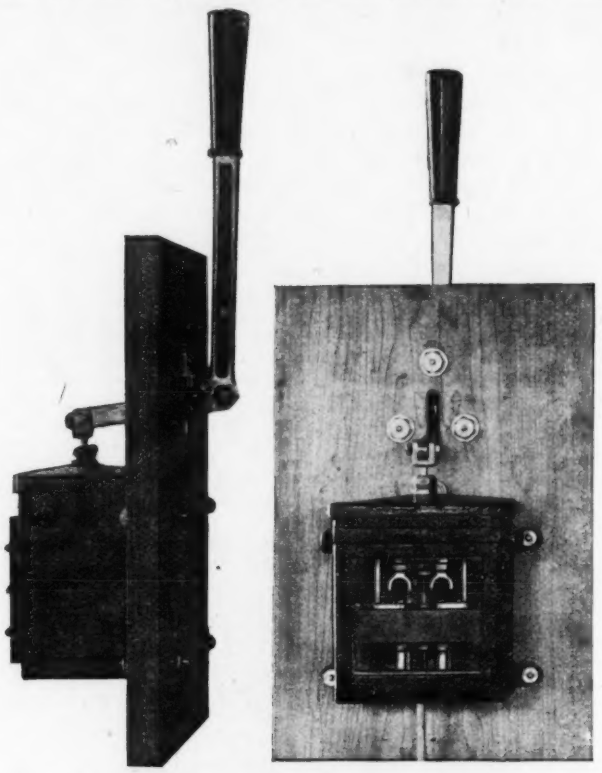
hence also for the determination of dielectric constants; a suitable indicator is a set of magnetized steel wires 1 cm long. The primary current consisted of the discharge of an influence macnine; the secondary coil was not enclosed in the primary, but was placed a few centimetres away with a coinciding axis; to maintain the constancy of the discharge potential the primary condenser was always charged very rapidly, as recommended by Jaumann.

MEASURING DISCHARGES. Witting. "Wied. Ann.," June; abstracted in "L'Eclairage Elec.," Nov. 19.—He describes a galvanometric method of measuring a succession of sudden discharges. The best results are obtained by using a method of multiplication or by the Toepler method. The former consists in reversing the direction of the current at the moment when the needle arrives at one of the extreme positions; the other method consists in reversing the current at the moment of the second change in the direction of the needle. He measured by these methods the current furnished by a machine of twenty plates; the results are regular, and show that the intensity of the current is within large limits, independent of the resistance of the circuit and the length of the spark.

MEASURING HIGH VOLTAGES. Puekert. "L'Eclairage Elec.," Nov. 19.—An abstract, with illustrations, of the description noticed in the "Digest" Oct. 22; it is a longer abstract than the French one noticed last week.

EDDY CURRENT LOSSES IN ARMATURES.—Lond. "Elec. Eng.," Nov. 25.—Several answers to the question how to determine the watts thus lost in a direct-current dynamo.

MEASURING HIGH MECHANICAL PRESSURES. Palmer. "Am. Jour. of Sc.," Dec.—A brief, illustrated description of a method of measuring very high mechanical pressures, by measuring the electrical resistance of a column of mercury subjected to this pressure. A column of mercury in a glass tube is placed in the vessel in which the pressure is produced, and contact is made at both ends, the column forming one branch of a Wheatstone bridge. Previous researches show that up to 2000 atmospheres the relation between the electrical resistance and pressure of mercury is a linear law. Experiments show that a change of pressure of one atmosphere could easily be detected; with reasonable care the errors of measurement do not exceed one part in 1000. Pressures were produced up to 4385 atmospheres.



SIDE ELEVATION AND REAR VIEW OF OIL BREAK SWITCH.

Telegraphy, Telephony and Signals.

RAILWAY SIGNALS. Reich. "Zeit. fuer Elek.," Nov. 20.—A brief, illustrated description of a system in which the train, after passing the signal, will itself operate the signal which it has passed, settting it to danger.

HIGH-SPEED TELEGRAPHY.—"Sc. Am. Sup.," Dec. 10.—A reprint from "Nature" of a short article on the Squier and Crehore method, known as the synchronographic system, the original descriptions of which have already been published in THE ELEC. WORLD,

CLEARING OUT SIGNALS. Clausen. "West. Elec.," Dec. 3.—A short article giving descriptions of the various systems in use for clearing signals in telephone centrals, after the completion of the conversation. The description is of a non-technical kind.

BRUSSELS.—"Elec. Eng.," Dec. 8.—A brief consular report on the new telephone station.

Miscellaneous.

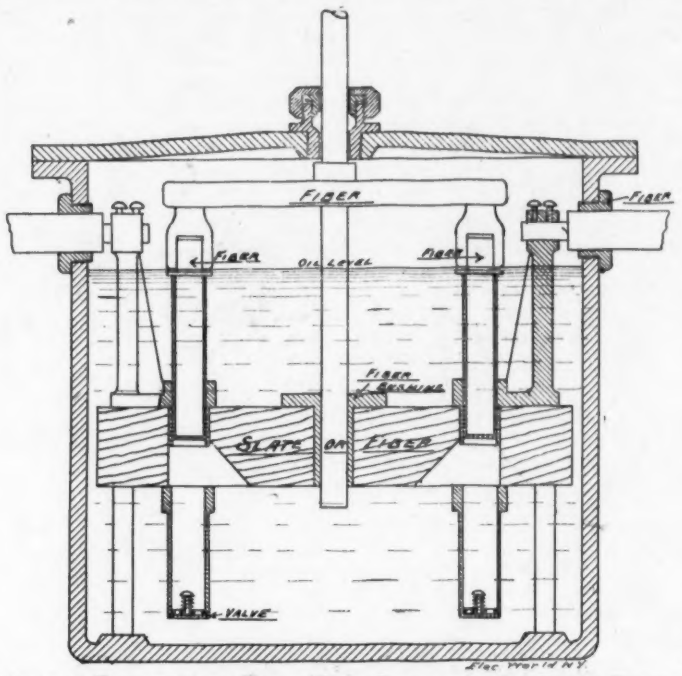
STATUS OF ELECTRICAL INVENTION. Rosenbaum. "Jour. Frank. Inst.," Dec.—The beginning of a reprint in full of the paper noticed in the "Digest" Dec. 3.

New Oil Break Switches.

These switches are enclosed in iron boxes varying in size, according to the capacities required, the two-pole, 20-ampere, 2500-volt box being 4x6x7 inches, while the three-pole, 300-ampere, 2500-volt box is 9x11x13 inches. These boxes are of cast iron, and are fastened to the back of the switchboard panel by four stud bolts through four lugs cast on the box. A right angle lever connecting with the draw-bar, hinged on the face of the panel, extending upwards, offers sufficient leverage to open or close the switch with little effort.

The wires run into the box through fibre bushings in the smaller sizes, while in the largest sizes cable connections are made outside of the box by means of brass sleeves; the wires pass through these fibre bushings (the latter extending to the binding posts), and are held in contact by means of screws set in the top of the posts. The current passes down the posts to contact plates cast with the posts. These plates and posts are mounted on top of a slate or fibre plate, as occasion requires, and through the plates a plug passes, carrying the current to a thimble below. This thimble is also cast to a contact plate, which is fastened to the bottom of the slate or fibre plate, and carries the current along to the next thimble, which connects with the outgoing plug. In this manner the current is carried up to the outgoing binding post and out to the line.

The number and size of the plugs is determined from the potential or pressure carried and the amount of current that must be broken. The present standard is that each plug shall break not over 625 volts, consequently very high voltage switches require a number of plugs or "breaks," while heavy currents demand large plugs, or plugs placed in multiple, but broken simultaneously in series. All of the conducting parts are made of steam metal, and the higher capacity plugs are reinforced with pure copper centres. These plugs fit with exactness into their receptacles, and are attached at the top by means of a fibre cap and metal yoke to a fibre spider, which is fastened to the draw bar, the lower portion of which passes through a fibre bushing or guide in the case of using a slate plate, thus insuring a straight pull on all the plugs simultaneously. The box is filled to the top of the plugs with a special acidless oil, and the switch is ready for service.



SECTIONAL ELEVATION OF THREE-POLE QUADRUPLE OIL BREAK SWITCH. CAPACITY 5000 VOLTS, 150 AMPERES.

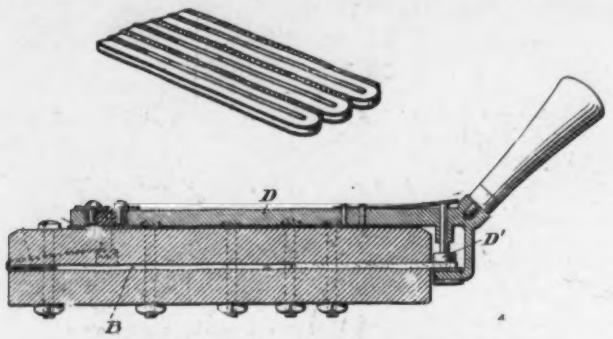
To operate the switch the lever on the face of the switchboard is pressed in, the draw-bar is forced downward and with it the spider, with all the plugs attached, and as the plugs enter the lower thimble the oil passes out of a valve, ground in place at the bottom of the thimble, and the switch is in use.

To open the switch the operation is reversed, and as the plugs are being drawn from the lower thimbles they close the valve and create a vacuum, which is increased until the plug leaves the thimble, which is the arcing point, or at least where one would naturally expect to see an arc. Just at this point the oil is drawn with great force between the two contacts by the vacuum, and the arc is "nipped in the bud."

The instructions given with these switches is to "tease the arc" when the switch is opened under full load, as no arc can form nor will the plug be injured a particle by repeated use. The switches are manufactured by the Cloos Electrical Engineering Company, Milwaukee, Wis.

An Improvement in Rheostats.

A type of rheostat designed to control large currents with a simple construction not liable to derangement is the subject of patent No. 615,419, issued to Mr. Charles Wirt, December 6. The rheostat material consists of a metallic strip or ribbon bent edgewise into a flat sheet somewhat as shown in Fig. 1, and inserted between heat-radiating cover plates either of slate or some such insulating material or of metal with an insulating sheet between. The path from terminal to terminal is designed to have no joints, and the contact with



Figs. 1 and 2.—An Improvement in Rheostats.

the moving part is made without wire connections, but directly on the ends of the loops of the strips. This is clearly shown in Fig. 2, where *B* is the conducting strip enclosed between slate slabs and making contact with the stud *D'* mounted in the arm *D*.

Efficiency of Worthington Electric Pumps.

The two accompanying diagrams will be interesting in showing graphically just what efficiency one may expect to obtain with an electrically driven mine pump. This test was run on an 11x12 horizontal triplex pump manufactured by Henry R. Worthington, New York, and driven through a double reduction of machine-cut spur gearing by two 65-hp General Electric Company alternating-current motors. The speed of the motors was 450 revolutions, and that of the pump 45, making a total gear ratio of 10 to 1. The normal capacity of the pump was 1250 gallons per minute, the head 350 feet.

The first test (Fig. 1) was run at constant speed and a variable head. The voltage of the motors was kept constant at 220, and the frequency constant at 60 cycles. The head was measured by pressure gauges on the delivery pipe, the quantity of water by the plunger displacement, less an allowance of 2 per cent. for slippage. The total input at the motors was measured by wattmeters placed in the main circuit. The following readings were taken :

EFFICIENCIES.

Volts.	Total pressure.	Head in feet.	Pump.	Motors.	Set.	Power factor.	Amps.
220	25	57.5	53.7	82.7	44.4	72.6	63
220	50	115.0	67.0	86.3	57.8	82.0	82
220	100	231.0	76.1	88.0	67.0	88.5	133
220	152	350.0	80.1	86.5	69.3	85.6	198

The second test (Fig. 2) was run under a constant head at variable speed, the pressure being kept steady at 100 pounds per square inch, and the voltage at 220. The following readings were taken:

EFFICIENCIES.

Cycles.	Gals. per min.	Pump.	Motors.	Set.	Power factor.	Amps.	Volts.
25	490	72.3	77.4	56.0	86.5	140	74
40	795	77.5	83.6	64.8	86.8	140	147
50	1,040	78.2	86.0	67.0	86.0	140	187
60	1,350	78.0	87.3	68.0	85.0	140	220

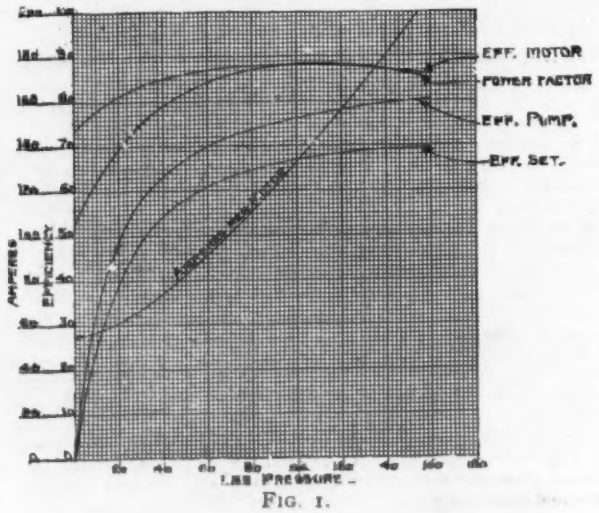


Fig. 1.

The test was run under the supervision of disinterested engineers, the efficiency curves being plotted directly from the data obtained. The first curve represents the efficiency of the motor, the second curve the efficiency of the pump and gearing, and the third the efficiency of the complete set from the wire to the water column. Considering that the water end had six single acting outside packed plungers and that the pump had just come from the shop, all the working parts being stiff and not yet having worked down to a perfect bearing, the results obtained are thought to be remarkably good.

A Tile Bolt and Lock.

The advantages of the device illustrated herewith will be at once recognized and appreciated by electrical contractors and wiremen. It has been devised for use in fireproof buildings, where the columns and girders are covered with

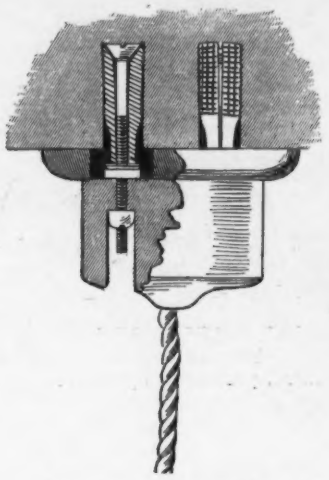


Fig. 1.—Ceiling Button.

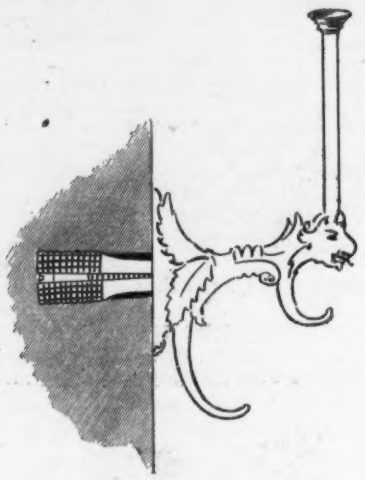


Fig. 2.—Ornamental Bracket.

tiling, and offers a safe and simple method for fastening insulators, rosettes and other electrical appliances to ceilings, columns or walls. After it has been properly set it cannot be pulled out, though it can be easily removed when desired.

The device consists of two pieces of metal with partially corrugated outside surfaces, which, when placed together, form a shape somewhat conical. The opening in the upper end when the two parts are together is countersunk, allowing the bolt head to which the insulator or other device is to be fastened to fit snugly between them. To place the bolt the two metal parts, with the bolt between them, are inserted in the hole in the tiling. A small concave washer slips over the bolt, and a nut is then screwed up close to the ends of the metal pieces. As the nut gradually tightens it draws the bolt head down into the space between the two parts and separates them, until it effects a tight binding at the sides of the hole. This leaves the shank of the bolt free, to which any device may be attached.

Fig. 1 shows a ceiling button attached to the bolt, and Fig. 2 shows how

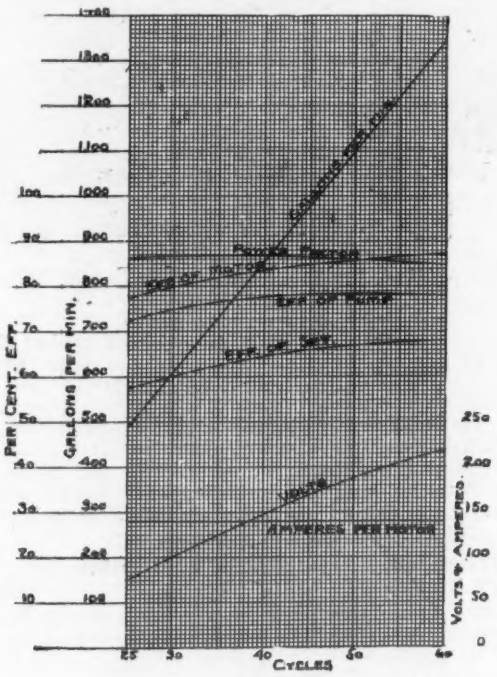


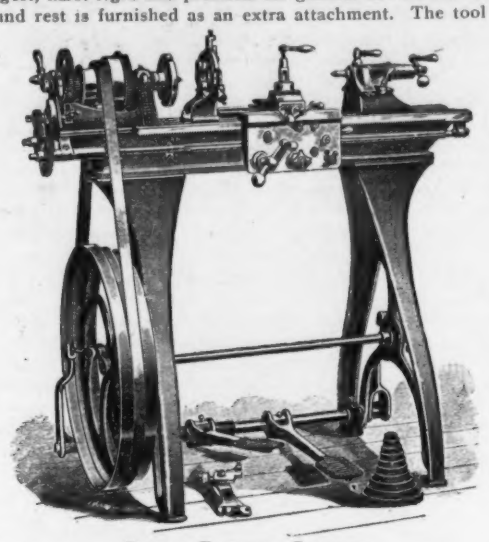
Fig. 2.

the tile bolt and lock may be used for the attachment of ornamental brackets to a wall.

These tile bolts and locks are made by the Western Electric Company in two sizes, the bolts being 3½ inches long by one-fourth inch in diameter and 2 inches long by one-eighth inch diameter.

"Star" Screw-Cutting Engine Lathe.

The lathe represented in the accompanying illustration will no doubt be of interest to central station and street railway managers who have machine or repair shops connected with their plants. The head has a hollow spindle made from a crucible steel forging, and the improved end-thrust ball-bearing reduces the friction 75 per cent. in the work of drilling. The tail stock has an adjustable side movement for turning tapers. The plain gib rest is said to be the strongest, most rigid and practical for general use on a lathe of this size. The compound rest is furnished as an extra attachment. The tool post is pro-



SCREW-CUTTING LATHE.

vided with an improved collar and shoe for raising and lowering the tool. The improved automatic friction cross and longitudinal feeds are actuated by a phosphor-bronze worm on the lead screw, which is splined. The feed may be thrown in or out of contact by simply turning a hand knob in the apron, and will feed in or out, right or left, cut screws right or left or may be thrown out of gear entirely by moving a lever in the headstock without changing the motion of the foot or driving power. The cross-feed secures perfect accuracy in turning or facing up work. The lead screw will cut all standard threads from 3 to 64 inclusive, without compounding the gears, and nearly all threads by compounding them. The lathe can be started and stopped instantly by foot power. This lathe is manufactured by the Seneca Falls Manufacturing Company, 422 Water Street, Seneca Falls, N. Y.

An Automatic Time Switch.

A novelty in the line of automatic devices for cutting out lamp circuits has been brought out by Messrs. J. Jones & Son, 66 Cortlandt Street, New York. There have been many devices of this character brought out for the purpose of

AN AUTOMATIC TIME SWITCH.

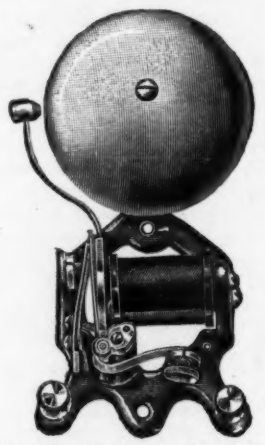
cutting out only, but this instrument not only cuts out but cuts in again at any predetermined time. Necessity often requires the closing of circuits at distant points not in proximity to the central station or switchboard, and at that particular time the entire attention of the engineer in charge is needed at another point of the engine. Here the automatic time switch does the service of a helper.

The apparatus is peculiarly adapted to the lighting of signs and for the turning on and off of window lights. The clock movement operates two cams, which make one revolution in twenty-four hours. The lower or switch-operating movement is wound up in the manner of an ordinary clock and furnishes the power for the operation of the switch. A combination of levers is connected with the switch handle in such a way that it can be moved up and down, according to the direction of movement of the mechanism. This apparatus will operate single, double, triple and four-pole switches. The regular clock movement is of the best make, so as to insure reliable time for the operation of the switch.

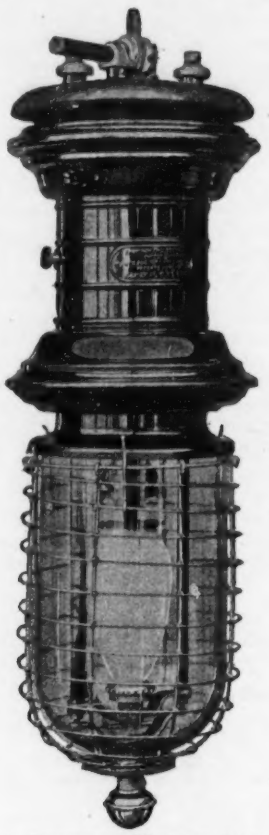
A Portable Arc Lamp for General Marine Work.

Adequate electric illumination of wharves, docks, warehouses, dry docks, shipyards, with their adjacent iron working shops, and the holds of vessels, while loading or discharging, demands a type of lamp somewhat different from that used for street or store lighting. It must be strong, compact and durable or it will not withstand the hard usage which such service will naturally give it; it should give a large volume of clear, white light, which will not dazzle the eyes of the workmen nor throw heavy shadows in already obscure corners; it should require little attention, and be so simple that it can be attended by an average lamp trimmer; lastly, it should require trimming not daily, but only at long intervals.

The marine enclosed arc lamp, manufactured by the General Electric Company, meets these requirements. It has been made the object of special design to adapt it to marine usage on shipboard or land. The mechanism is compact, simple and reliable, and is protected from injury or the effects of the weather by a stout metal casing. It is only necessary to renew the upper or long carbon once in 100 to 150 hours. The outer globe is cylindrical in shape, of thick glass and protected from injury by a heavy wire guard. The globe can be lowered by a half turn of the thumbscrew at the side, and when pushed back in position is automatically and securely locked. The lamp is only 28 inches long. It can be carried from place to place if necessary or may be permanently fixed in place like an ordinary arc lamp. The lamp can be used on a 110-volt circuit, and can be adjusted for 4, 4.5 or 5 amperes, the latter being the standard.



AN IMPROVED ELECTRIC BELL.



A PORTABLE MARINE ARC LAMP.

Many of these marine lamps have been installed in locations such as those mentioned above, and have in every case given very satisfactory service.

An Improved Electric Bell.

A new type of electric bell has just been brought out by the Rousseau's Electrical Works, Inc., 329 Fourth Avenue, New York. As shown in the cut above, the two spools are in a plane at right angles to the bell frame, instead of parallel. This gives an equal pull from both pole pieces, thereby increasing the power of the blow. The most notable feature of this bell, however, is the multiple contact, whereby a large surface is obtained and the sparking is made to take place between two or more contact points, instead of at one. This is accomplished by having the usual contact spring on the armature much wider and split into two or more fingers, these fingers being brought into contact with another spring insulated from the bell frame. The adjustment of the contact is made by a screw bearing on the second spring, but insulated from it. On a 3-inch bell the contacts have three fingers, giving a surface of over one-quarter of an inch long and one-thirty-second of an inch wide. If one of the fingers becomes burned there will still be two left. The continued vibration of the bell, it is stated, removes the oxide from the burned finger. It is therefore almost impossible to damage this bell at the contact point by excessive current. The contacts are of pure platinum. The bell has a double adjustment and locked binding posts. The armature is pivoted in brass bearings and, due to the magnet arrangement, has a very long leverage. The design of this bell is the result of twenty-five years' experience in the manufacture of bells, and those desiring a serviceable instrument will do well to consider its merits.

NEWS OF THE WEEK

Financial Intelligence.

THE COMMERCIAL CABLE COMPANY has declared a quarterly dividend of 1¾ per cent., payable January 3, 1899.

INCREASED DIVIDEND.—The directors of the Metropolitan Street Railway Company, of New York, increased the dividend rate from 1¼ quarterly to 1¾ per cent. A dividend at the latter rate was declared last week, payable January 16, 1899.

THE NASSAU ELECTRIC RAILROAD COMPANY, Brooklyn, reports gross earnings during the quarter ended September 30, $685,254, an increase of $52,213 over the same period last year; net earnings, $294,007, a decrease of $104,817; total income, $295,981, a decrease of $95,514; surplus, $75,253; decrease, $117,746.

GENERAL ELECTRIC DIVIDENDS.—In a circular recently issued by the General Electric Company to its stockholders it is stated that the recent dividend of $17.50 on the preferred stock equals the unpaid accumulative dividends upon that stock for eighteen months, beginning July 1, 1894, and ending December 31, 1895.

Special Correspondence.

NEW YORK NOTES.

AT A MEETING of the Board of Directors of the Electrical Exhibition Company, held in this city on December 7, Mr. H. L. Shippy was elected vice-president and a director in place of Mr. F. W. Roebling, resigned.

MR. HIRAM S. MAXIM delivered an illustrated lecture before the American Society of Civil Engineers at 220 West Fifty-seventh Street, this city, on Wednesday evening last. The apparatus used in his artificial-flight experiments was described, and the evolution of the automatic gun was illustrated. A small Maxim gun was exhibited and blank cartridges fired.

SPECIAL TROLLEY CARS FOR SCHOLARS.—In the last issue of THE ELECTRICAL WORLD reference was made to the special car service for the accommodation of the scholars of Packer Institute in Brooklyn. It now turns out that this is not the first case where special trolley cars have been provided for the use of scholars in that borough. The special school-car service originated with President Rossiter, of the Brooklyn Heights Railroad Company, who is an interested trustee in Adelphi College, and such cars have been running to Adelphi since September 1, 1897. Therefore Adelphi precedes Packer by over a year in its special-car service.

TO VESTIBULE STREET CARS.—It is proposed to compel the street railway companies to equip their cars with vestibuled platforms, and a public hearing was given on the subject by the Railroad Committee of the Board of Aldermen on December 9. The railroad companies object to the measure. Mr. B. F. DeFrece spoke for the Third Avenue Railroad Company, and contended that the glass windows would become misty in stormy weather and obscure the motorman's view of the track ahead. Another contention was that the motorman, gripman or driver, as the case may be, would be more liable to take cold inside of vestibules than if he had no protection at all. This solicitude of the railroad companies for their employees is altruistic and highly commendable.

ELECTRICAL ENGINEERS IN THE WAR.—The 192d meeting of the New York Electrical Society was held at the College of the City of New York on Wednesday evening, December 14. Col. Eugene Griffin, who has recently returned from active service in Porto Rico, as colonel of the First Regiment United States Volunteer Engineers, made an address on "Ideas Underlying the Organization of the Volunteer Engineer Corps; the Work Accomplished by It in Porto Rico and the Opportunities of Future Usefulness." Mr. W. D. Weaver, late chief engineer of the United States steamer "Glacier," and F. W. Roller, late chief engineer of the United States steamer "Nashville," also made addresses on the subject of electrical and engineering work in the navy during the war. The relations of the engineering profession to both the army and the navy were clearly pointed out by the speakers.

THE UNITED STATES TELEPHONE COMPANY, of this city, which was incorporated at Albany on December 5, has acquired the rights of a telephone system invented and developed by Mr. Elias E. Ries, an electrical engineer, of this city. In this system all calling and switching operations are effected automatically by means of a simple mercurial contact, the mercury being contained in a sealed chamber located at the back end of the receiver. The mere act of lifting the receiver to the ear rings up the central office, thus doing away with the hook-switch and magneto, the latter being located at the central office. Mr. Ries claims that by means of his system telephone service can be conducted at one-half the cost of service under the existing methods. The new company proposes to enter into the manufacture of its telephonic apparatus and to introduce its system through existing companies or new sub-companies.

A FATAL ACCIDENT WITH AN ELECTRIC ELEVATOR.—On the afternoon of Tuesday, December 6, one man was accidentally killed and two others seriously injured by the fall of an elevator in the eleven-story building at 46 Pine Street. The elevator was driven by an Otis double-worm gear electric hoist. The nature of the accident was rather peculiar. The car came down to the first floor—below which it appears there is only 8 inches clearance to the bottom of the shaft—at full speed, the attendant apparently not cutting off the current as he should. It is also claimed that there is only 18 inches clearance between the counterweights and the I beams supporting the overhead sheaves when the car is at the ground floor level. The automatic limit stop on the machine had been found to be out of order by an inspector that morning. At any rate, the car ran into the bottom bumpers at full speed, and the momentum and motor torque pulled the counterweights up against the I beams, when the counterweight frames sprung sideways, letting the weights themselves—which were, as usual, merely slipped in between vertical tie bars—fall out, and four weights, each weighing in the neighborhood of 70 pounds, fell the full height of the shaft and through the car.

THE ANNUAL MEETING of the Electrical Committee of the Underwriters' National Electrical Association was held at 34 Nassau Street, in this city, on December 6, 7 and 8. Several matters of more or less importance were brought before the meeting for its consideration. Very few changes were made in the National Electrical Code, none of them being of any great importance. The subject of changes in installations and wiring rules was referred to a committee of seven. Some changes were made in the specifications for sockets, and changes in other wiring devices, such as switchboards, cut-outs, etc., were considered. It is likely that other changes will be made in the specifications for restandardizing and reproportioning various wiring devices, but nothing definite in this direction was arrived at. Definite action was taken regarding 220-volt lamp sockets. No changes were made in the requirements for central station construction and the installation of switchboards and dynamos therein. Efforts were made to agree upon a proper test for transformers so as to lessen the liability of breakdown between primary and secondary circuits. The recommendations were referred back to the various organizations allied in the movement for final action. It was resolved as the sense of the meeting that on and after July 1, 1899, all inspectors should refuse to accept any devices or materials on new work not enumerated in the edition of the list of approved devices and materials of the above date. There were about forty representatives in attendance at the meeting, coming from all parts of the country.

THE NEW ELECTRIC LIGHT AND POWER COMPANY'S PLANS.—The true nature of the New York Gas, Electric Light, Heat & Power Company, which was incorporated at Albany recently, and which has at odd times since excited a vast amount of curiosity and speculation, is beginning to be revealed. Although nothing authentic has yet been given out regarding the plans of the company, it is now generally supposed that it purposes acquiring control of all the existing lighting and power interests in Greater New York, and conduct them under one management. In support of this belief comes the announcement made on Saturday last that the Hon. W. C. Whitney had acquired the controlling interest in the Mount Morris Electric Light Company, the Edison Electric Illuminating Company, the Manhattan Electric Light Company and the Empire Subway Company, all of Manhattan. Mr. Whitney, it is stated, is one of the principal backers in the New York Gas, Electric Light, Heat & Power Company. It is also reported that the new company has acquired an interest in the New York Telephone Company, which controls the Empire City Subway Company and the subways of the Consolidated Telegraph & Electric Subway Company. The interest in the telephone company thus acquired, it is stated, will enable the new company to use all the high-tension wires in the subways for light, heat and power purposes, the telephone company retaining control of the low-tension wires for telephone purposes only. The announcement that the deal for the acquirement of the older lighting companies had been completed seems to have been premature. There appears to be good reason, however, for the belief that the new company will have secured the controlling interest in them all by January 1 next. It is stated that negotiations are now pending between the new company and the Mount Morris Company, but that no definite settlement has yet been arrived at.

PHILADELPHIA NOTES.

MR. LAWRENCE W. FRANK has purchased the business carried on under the title of the Technic Electrical Works, at 214 New Street, Philadelphia, and will continue at the same address. Mr. R. L. Binder will act as manager. With increased capital, modern equipment and carrying of good stock, Mr. Frank and Mr. Binder hope to do even a larger business than was done by the Technic Electrical Works. THE ELECTRICAL WORLD wishes them every success in their new departure.

ELECTRICAL GOODS IN BRAZIL.—A traveling representative of the Philadelphia Commercial Museum has just returned from Brazil, and makes an interesting report on the trade in electrical goods in that country. He states that "the trade is growing by leaps and bounds, it being only a few years ago that electric railways, lighting, power, etc., were unknown in any part of the country. Now almost every town and city within 300 miles of the coast is either lighted by electricity or has the project under consideration. Many of the mining companies and cotton cloth mills through the interior have plants now in operation, supplying them with both light and power. Several of the large plants have come from England. It is well known that the trade is controlled as regards supplies almost exclusively by England and Belgium. The United States comes in for a fair share of the trade in electrical machinery. Arc and incandescent lamps, fittings, carbons, wire of all kinds, electric bells, batteries, electricians' tools and gloves, zincs, sal ammoniac, etc., are in de-

mand in the towns along the line of the Central Railroad, between Rio and Sao Paulo, and Rio and Bello Horizonte, as these towns at present rely on the Rio merchants for their supplies. Along the line from Rio to Sao Paulo are many towns in which it might be advantageous to have agents. A competent salesman, familiar with the Portuguese language, traveling through this section could do wonders in the way of securing orders and appointing responsible agents. This may also be said of nearly all the interior cities, as attention so far has seemingly been paid only to the large cities on the coast, and even there not to the extent the trade possibilities deserve.

BUFFALO AND NIAGARA FALLS NOTES.

THE REVIVAL of the Pan-American Exposition scheme cannot fail to be of interest to electrical people. As it looks now the exposition will go through with a rush, as the city fathers of Buffalo have indorsed it and will do what they can for it.

THE WOOD-WORKING FACTORY of Messrs. Alcott, Ross & Scully, at Dunkirk, has been furnished with 700 incandescent lights in order to permit running all night as well as day. The current comes from the new incandescent system installed in the city last year.

THE RECENT STORMS have interfered with the transmission of the electric power from Niagara Falls to Buffalo. For some time the street railway company was obliged to use its own power. It is supposed that the heavy snow and winds of the past week or two have proved too much for the overhead line. The managers of the company in Buffalo have not explained the cause and an effort to find it failed.

THE PROJECTORS of the power line to Depew from Niagara Falls have not been able to do any work this season beyond the securing of the right-of-way, which is reported to be complete except in case of corporations where signatures are dependent on meetings held at long intervals. The plan is to tap the line to Buffalo at the transformer station at North Tonawanda, or bring up a separate line to that point from the power house and lead it off from there to Depew. It will be easy to modify the current at that station. Negotiations with the Buffalo Valley trolley line, which is to be built next year, are in progress. It is the plan to build a line something over three miles long southward from Depew to connect with the line of this road. Inquiry for power at Depew is sufficient to warrant the building of the line as early in the spring as possible.

CHICAGO NOTE.

A TEMPEST IN A TEAPOT.—The talk about lynching and mobbing of aldermen and others in connection with the fight over the street railway franchises came from hot-heads, and the excitement was greatly exaggerated by the newspapers. The trouble is largely a newspaper creation. The opposition in the City Council to the ordinance granting a fifty-year extension of franchises to the street railway companies seems to be strong enough to defeat the measure for a year at least. Mayor Harrison thinks that the joint committee on streets and alleys will not recommend the passage of the ordinance. It is thought that Mr. Yerkes and his street railway associates will fail to secure the enactment of the measure, and that a compromise may be effected later on a basis of twenty-year franchises. The present franchises expire in 1903. It is stated that several aldermen who favored the extension have received threatening letters. Many public meetings have been and are being held in various parts of the city to protest against the franchise extensions.

ST. LOUIS NOTES.

TO BURY THE CITY'S WIRES.—E. Ruebel, secretary, and Charles E. Sharp, treasurer of the Southern Electrical Supply Company, who have been awarded the contract for burying the city's wires, say it will be impossible to complete the contract by December 21. It will be near the end of January, as they are allowed ten days for filing a bond and beginning work, and have six weeks in which to complete the contract.

NO CAUSE OF ACTION.—In the case of the Cass Avenue & Fair Grounds Railway Company, which asked an injunction in the Circuit Court to restrain the St. Louis & Suburban Railway from using the tracks of the plaintiff, violation of the Julian law was alleged as the cause for the injunction. The judge held a day or two ago that, inasmuch as the Julian law had been annulled by the Supreme Court, there was no cause for granting the injunction asked for. This case becomes interesting in view of the sale of the line seeking the injunction to the stockholders of the Southern Electric line, over whose tracks the Suburban loop will also run. It has been stated that the Southern Electric Company and the Suburban had reached an agreement as to the joint use of tracks and the action of the former company with regard to its newly acquired tracks.

STREET RAILWAY DEALS.—Mr. Corwin H. Spencer and Charles F. Orthwein, representing the stockholders of the Southern Electric Railway Company, have purchased the property of the National Railway Company, known as the Hamilton Syndicate. The price said to have been paid was $3,000,000. The deal was made in Chicago, and resulted in the transfer of an important property from an outside corporation to St. Louisians. The property sold includes the Northern Central, Cass Avenue & Fair Grounds, Union, Citizens, Baden and Southwest lines, all electric, and the St. Louis line or Broadway Cable. The aggregate mileage represented is 80.37 of electric and 14.67 of cable. The second and greatest transaction was the sale of the Lindell and the Missouri Railway System to the Metropolitan Street Railway Company, of New York. The consideration is said to be $8,500,000. The deal was completed in New York, and by it a valuable property passed from the control of St. Louis men to outsiders. There were reports that the Scullin system had also been sold, or was being negotiated for, also the Suburban Company's properties. Both the latter rumors were denied. It was stated at the office that the Union lines had not been sold, and that no offer had been made for the property. At the office of the Suburban Company it was emphatically declared that no offer had been made for the road.

PACIFIC COAST NOTES.

THE MOUNT WHITNEY TELEPHONE COMPANY, of California, after passing through many vicissitudes, is doing a growing business under the management of J. H. McFarland. The American Electric Telephone Company, of Chicago, supplies the instruments now being installed.

THE UNION IRON WORKS COMPANY, of San Francisco, has installed a 100-ton electric hoist under its large shears in the shipyard. It is a double hoist, operated by two 25-hp motors. A third motor operates a "gipsy," and a small motor is used to turn the screw. The electric work was done in the shops of the electrical department of the works.

THE SUNSET TELEPHONE & TELEGRAPH COMPANY recently announced that its Pacific States telephone companies now have in operation 21,000 miles of lines, serving 44,000 subscribers in 1400 cities and towns. Rates from San Francisco are, for quarter-minute switches, to Southern California points, 50 cents; to Puget Sound cities, 75 cents; to Eastern Washington and Idaho, $1.

THE SUBMARINE CABLE WORK in the San Francisco Bay, most of which is recent, was inspected by Chief Signal Officer Greely while on his tour of the Pacific Coast. He made a thorough examination of the electrical installations at the Coast fortifications. A complete system of telegraphic and telephonic communication will be established between San Francisco and the adjacent forts. The Columbia River and Puget Sound fortifications will have similar connections with neighboring cities.

CANADIAN NOTES.

THE CITY COUNCIL of Toronto has requested the electric street railway company to make a trial of various fenders, with a view to the adoption of the one found most efficient.

ON DECEMBER 17 the ratepayers of Galt, Ont., will vote on a by-law to raise $67,750 to purchase the gas and electric light plants. The company owning these plants has offered to sell at that figure.

IT IS PROPOSED to extend the Ottawa Electric Street Railway to the town of Britannia, about eight miles from Ottawa. The people along the route are endeavoring to bind the company to an agreement giving them city rates.

OWING TO the small number of tenders received by the city council of Toronto, Ont., for the installation of a municipal electric light plant it has been decided to accept none. From the tenders submitted it was found impossible to arrive at even an approximate cost of an electric plant. No tenders were received from Canadian manufacturers. In this connection the Anglo-American Electric & Supply Company has made a proposition to supply electricity to the city. Power is offered at cost after paying a dividend of 10 per cent. to the shareholders upon a capital stock of $5,000,000. It is guaranteed that the cost to the public will not exceed 1 cent per horse-power per hour.

NOTICE IS GIVEN on behalf of the Quebec, Montmorency & Charlevoix Railway that application will be made at the next session of the Dominion Parliament for an act amending the act incorporating the railway in the following particulars: To change the name of the company to the Quebec Railway Light & Power Company, to ratify the purchase of the property and franchise of the Quebec District Railway Company by deed passed at Quebec on June 29, 1898; the issues of bonds and stock made for the purpose of paying the purchase price thereof, and to authorize the company to build a line of railway or tramways in the counties of Levis, Bellechasse, Dorchester, Beauce and Lotbiniere; to ratify the purchase of the property, works, plant, buildings, machinery and capital stock of the Montmorency Electric Power Company, and the issues of bonds and stock made by the Quebec, Montmorency & Charlevoix Railway Company in connection with the purchase.

FRENCH NOTES.

INDEMNITY FOR INTERRUPTION OF TELEGRAPH SERVICE.—Owners of private wires have hitherto been made to pay the entire amount of the dues required by the state, notwithstanding any interruption which their service might happen to suffer. Following the practice in use in the telephone service M. Marnéjouls, Minister of Commerce, has recently decided that any interruption in the service of a private line exceeding fifteen days will entail a diminution of the royalty to be paid (which is 15 francs per kilometre), proportional in amount to the length of the interruption.

ELECTRICITY IN THE NAVY.—Following up the circular letter of September 12 last, regarding the acquisition by the navy of electrical workmen under a three years' volunteer enlistment provision, the Minister of the Navy has sent to the vice-admirals, the army corps commandants and the naval prefects a set of examination papers on theoretical and practical points, which all candidates will be required to pass. The manual tests will consist of three pieces of work, to be selected from each of the three groups denoted by the letters A B and C. A (1)—To make up a joint in a stranded conductor; (2) splice two conductors together; (3) prepare a wire brush; (4) bevel a brush; (5) restore a brush, the wires of which have been bent. B (1)—Put together a switch; (2) put together a push button; (3) make a fuse; (4) make a terminal; (5) make a socket to fit a given incandescent lamp. C (1)—Take a Leclanché cell to pieces and set it up again; (2) take a vibrating bell mechanism to pieces and set it up again; (3) to cut a bell or a galvanometer into a given circuit; (4) being provided with a battery, a bell and a push button, to arrange them properly in circuit.

POWER FROM THE RHINE.—The great Niagara enterprises of the United States and Canada are being imitated in some of the Swiss cantons along the Rhine. The actual work has been for some time under way, and

will reach completion before long, when there will be some 1600 horse-power developed by twenty turbines ready for distribution. The greater part of the output is already contracted for by private individuals and companies, who will consume it in their own service. Simultaneously with the completion of the hydraulic developments it is expected to complete a large aluminum factory, which will absorb some 2000 horse-power. This industry has assumed considerable volume in Switzerland, and may even come into competition with similar works in the United States. The falls of the Rhine are also to furnish electric power for a railway from Frich to Aarau. The hydraulic work, which will be at Rheinfelden, has been started. The application of electricity to power work is bound not only to make great changes in the operating conditions of existing industries, but it should open up an industrial future of a magnitude scarcely conceivable at present for countries like Italy and Switzerland, where water courses are numerous and may be readily utilized for the production of cheap electrical power.

ELECTRIC TRACTION ON CANALS.—Experiments have been going on with a new electric towing machine built at the shops of the firm of Detombay & Delange, at Hoboken-lez-Anvers, after drawings made by M. Maurice Delange. The dimensions of the boat are: Length, 50 feet; breadth, 11½ feet; depth, 8 feet; draught, 5 feet 9 inches. A Jaspar-Melotte motor is mounted directly on the screw shaft. Current is generated by gas engines fed by carburetted air, according to a system patented by the Aeropetrole Company. With electrical machinery having an efficiency of 85 per cent. better economy is obtained in this way than would be the case if the gas engines acted directly on the screw. Moreover, it is easier to arrange for change of speed. The gas engine is rated at 25 horse-power. This form of prime mover has the advantage of absence of boilers, coal bins and stoker. The boat can be got under way at a moment's notice, and intermittent working is possible without the necessity of keeping up the fire. These qualities, of course, carry with them absence of smoke and smell and any superfluous weight. The simplicity, precision and economy of this machinery make the boat an almost ideal traction machine; it would seem to be the true solution of a problem that has long bothered engineers. The cost of operation is brought down to one-fifth cent per ton kilometer. The ability, when once started, to manufacture its own gas as needed renders this motor almost indispensable in places where overhead lines cannot be erected. The carburator weighs about 2200 pounds. The cooling of the cylinder and the carburator is accomplished by a stream of cold water, which circulates between them continuously. The exhaust gases are recarburetted and are used for lighting and heating the boat. The electrical part of the outfit was furnished from the Jaspar establishment at Liège. The generator runs at 550 to 600 r. p. m., and at 500 volts normally. The motor revolves 300 times per minute under full load; it has four poles and the armature is drum wound. The fields are of steel, and the winding, which is in series, is in sections. A controller arranged by M. Melotte, director of the Jaspar shops, provides a very heavy starting torque and a quick start. Reversal of direction is obtained by a switch, which reverses the current in the armature.

General News.

New Incorporations.

THE ACME ELECTRIC LAMP COMPANY, New Brunswick, N. J., has been incorporated with a capital stock of $500,000. Incorporators: Louis A. Jackson, Ralph W. Booth, Ralph W. Booth, Jr., New Brunswick, N. J.

THE CARTER-HAYS ELECTRIC COMPANY, Louisville, Ky., has been formed for the purpose of manufacturing, repairing and selling electrical appliances. The incorporators are L. D. Curtis, E. W. Hays and H. C. Hays, Louisville. Capital stock, $5000.

THE DELAWARE COUNTY ELECTRIC LIGHT & POWER COMPANY, Clifton Heights, N. Y., has been formed to supply light, heat and power by electricity. Among the incorporators are C. M. Wagner, E. O. Kane, Lansdowne; R. S. Austin, Philadelphia; S. Haigh, Aldan, and J. S. Austin, Yeadon. Capital stock, $5000.

THE ST. PETER TELEPHONE COMPANY, St. Peter, Minn., has been formed for the purpose of constructing a telephone exchange and telephone lines at St. Peter. The incorporators are H. P. Proctor, Augustus Proctor, Frank A. Chase, J. H. Chase, Viroqua, Wis., and Walter S. Proctor, St. Peter, Minn. The capital stock is $10,000.

THE CO-OPERATIVE TELEPHONE COMPANY has been incorporated at Columbus, Ohio, with a capital stock of $50,000. The incorporators are George Riddle, Frank H. Howe, Charles A. Spinny, W. B. Childers, W. B. Earnhart, A. C. Ross, E. H. Reel, George D. Jones, J. S. McLeon, Alfred E. Lee, W. M. Payne, G. D. Owen, A. B. Summers, Charles W. Goff, Edgar J. Pocock, Jonathan F. Linton, F. Siegel, W. J. Davidson, Charles F. Galloway and John F. Fergus.

The Telegraph and Telephone.

OMAHA, NEB.—The Nebraska Telephone Company proposes in the spring to extend its telephone line from Genoa to Neligh.

DETROIT, MICH.—The Valley Telephone Company has made connections via Saginaw and Flint with the Independent Telephone Company, of Detroit, for permanent service.

PHILADELPHIA, PA.—The Home Telephone Company will extend its lines from Watsontown, Northumberland county, to Williamsport, and will connect its Northumberland county circuit with the Independent lines in Centre county.

BOSTON, MASS.—The New England Telephone Company has made a new rate for non-subscribers between Dalton, Hinsdale and Pittsfield. The charge hereafter will be 10 cents for a conversation of three minutes, and 2 cents a minute for additional time.

DOYLESTOWN, PA.—The Standard Telephone Company will invite proposals for the extension of its line from Newtown to Doylestown and from Eden to Bristol. It is proposed to later extend the line from Newtown to Trenton via Yardley and Morrisville.

WAUKESHA, WIS.—The Wisconsin Telephone Company has commenced the erection of a metallic circuit line from here to Elkhorn by way of Genesee, Eagle and Mukwonago. The old grounded line between here and Mukwonago will be abandoned as soon as the new line is built.

NEW HAVEN, CONN.—The Southern New England Telephone Company has mortgaged its property to the New Haven Trust Company for $1,000,000. The money will be used to pay off the present mortgage and to make improvements on the line. Five per cent. fifty-year bonds will be issued to cover the amount.

SHARON, PA.—A movement is on foot to consolidate the Citizens' Telephone lines of Lawrence and Mercer counties and extend lines to Meadville, Oil City, Franklin, Erie and Youngstown. R. H. Adams, a capitalist of Baltimore, has assumed control of the New Castle lines, and he is at the head of the project.

NORTH VERNON, IND.—William N. Turner and Emma B. Turner, of Canton, Mo., have been granted a telephone franchise by the common council of this city. Business houses are to be charged $1.50 a month and residences $1 a month. Long-distance connection will be over the Independent line, now constructed as far as Elizabethtown.

NEW YORK, N. Y.—At a meeting a few days ago of the Merchants' and Manufacturers' Board of Trade the telephone committee reported a legislative bill making it unlawful for any telephone company to charge over $50 a year for a local telephone service of less than 1000 messages in cities of 500,000 population and over. Another section of the bill provides that in the same size cities not more than 5 cents shall be charged for each message in excess of 1000. It is provided that violation of the law shall be punished by a fine of $100.

BOSTON, MASS.—The Massachusetts Telephone & Telegraph Company has applied to the city government for franchise rights to open streets, lay and maintain wires, etc., and public hearings are to be given on the question. The company was incorporated Nov. 23, with a capital of $10,000, but the petitioners declare that this amount is merely nominal, and that they have unlimited capital behind them. They propose a telephone service at less than one-half the Bell Telephone Company's rates, and claim that they will put wires underground and use instruments of the latest style. The five incorporators are Zephaniah H. Holbrook, of Cambridge; Frederick A. Spear, of Lowell; Silas P. Chase, of Reading; Wilbur F. Lakin, of Quincy, and Paul Faber, of Boston.

CHICAGO, ILL.—The United Telegraph, Telephone & Electric Company, of Chicago, has just issued $500,000 6 per cent. twenty-year gold bonds for the purpose of extending its present plant and to also make connections with outside cities and districts for long service to meet the demands of the people in the southern part and suburbs of the city. The proposed district to be embraced by this company contains more large factories than any territory adjacent or within the city's limits. The district embraces South Chicago, Hammond, Hegewich, Pullman, West Pullman, Kensington, as well as every other manufacturing district in this section of the city. The directors are Thomas W. Sennott, John G. Earle, James S. McConnell, W. B. Owen, James D. Lacey, Edward P. McConnell, Joseph N. Hagins, Hugh A. Holmes, J. E. Smith, mechanical superintendent and electrical engineer for P. D. Armour & Co.

PHILADELPHIA, PA.—Councils' electrical committee has agreed to report favorably to councils the ordinance to amend the ordinance granting privileges to the Standard Telephone Company, under which the company is held by the city authorities to be in default, and on account of which alleged default the city solicitor has brought suit for the forfeiture of the company's bond of $100,000, with the bankrupt Chestnut Street Trust Company as surety. The principal "amendments" to the bill, which was assumed to have become defunct through failure to comply with its provisions within the specified time, give the company the right to erect wires "over and across" the streets of the city, to purchase or lease conduits belonging to the city or other corporations, to mortgage its property and franchises to secure its bonds, and extending to four years the time in which it must be prepared to furnish 2000 telephones to subscribers.

WASHINGTON, D. C.—The Cuban telegraph lines will be operated and controlled by the United States Government, inasmuch as they belonged to the Spanish Government and were not private property. They cover about 2000 miles. General Greely has ordered Colonel Dunwoody of the Signal Corps to go to Cuba and take charge of the lines. Colonel Dunwoody will make his headquarters at Havana. The lines will be repaired by Cubans, under the direction of the Signal Corps. All the military camps are to be connected by telegraph. Several lines have been constructed in Santiago province and Pinar del Rio, and the work of constructing a line from Puerto Principe to the coast is now going on. Companies of Signal Corps men are at Santiago, Puerto Principe, Pinar del Rio and Havana, but it is proposed to considerably augment this force when the Government takes charge of all the lines.

CLEVELAND, OHIO.—The Cleveland Electric Illuminating Company has begun suit against the Home Telephone Company, the Reserve Construction Company and Maxine Reber to enjoin the defendants from carrying out their present plans in the erection of the lines of the Home Telephone Company. The petition says that the defendants are proposing to erect poles near the poles of the plaintiff, upon the same side of the street, and to string wires in close proximity to the plaintiff's wires, which, it is claimed, will endanger the lives of the employees and of the general public. It is also claimed that the users of telephones will be in danger. It is further claimed that the proposed method of erecting the lines is unnecessary, a violation of the plaintiff's rights, and that it is practicable for the defendant to erect poles without interfering with the rights of the plaintiff. Judge Ong granted a temporary restraining order. Bond was required in the sum of $10,000.

ELECTRIC LIGHT AND POWER.

FLINT, MICH.—The People's Electric Light Company, of Flint, will double the capacity of its plant at a cost of about $25,000.

CRAWFORDSVILLE, IND.—Messrs. Carr & Niestadt, of this city, have just completed a 100-light plant for the Yount Woolen Mills, Yountsville, Ind.

ROCHESTER, N. Y.—Mayor Warner intends to send a communication to the Council in which he will recommend the establishment by the city of an electric plant to furnish light for the streets and all the municipal buildings, including the public schools.

CLINTON, ILL.—At a regular meeting of the City Council the question of municipal ownership of electric lights was discussed. The light committee was instructed to investigate municipal ownership and report as soon as possible. The electric light company would be willing to let the city purchase its plant.

ST. AUGUSTINE, FLA.—The Florida East Coast Hotel System is now wiring and installing a new plant at the Royal Victoria Hotel, Nassau, N. P., Bahama Islands. A new plant will be installed in the Hotel Ormond at Ormond, Fla., iron conduit being used in the wiring. All this work is being carried on under the supervision of Mr. A. T. Best, electrical engineer for the hotel system.

HAGERSTOWN, MD.—The City Council unanimously passed an ordinance to establish a municipal electric light plant, and providing for the sale of $60,000 of bonds to pay for the plant. The present contract for lighting the town is with the Hagerstown Railway Company. The city contends that the contract expires two years hence. The company claims it runs for seven years longer. Mayor E. M. Schindel signed the ordinance.

WESTERVILLE, OHIO.—On December 1 the lights of the new Westerville Electric Company were turned on for the first time, and the forty-six 32-cp incandescents and ten arc lights illuminated the town far better than anyone had expected. Mr. E. S. Aldrich, the manager, says that the demand for private lighting is great, and several hundred lights will be immediately wired into stores and houses. The contract with the town is for five years at $1200 a year, twenty-five nights each month.

WASHINGTON, D. C.—One of the naval surgeons has reported against the present system of lighting warships by electricity. The protest is contained in a report submitted to Surgeon-General Van Reypen by Passed Assistant Surgeon E. P. Stone, who has been stationed on board various naval ships, and who is now on duty in Washington. He notes that medical literature is beginning to furnish cases of eye affections, and even blindness, resulting from the improper use of electric lights. The subject is a serious one, Dr. Stone says, and should engage the attention of the authorities. He adds: "I have myself seen several cases in the service which I considered directly due to improper use of electric lights, and which were relieved by using the light properly placed. This subject is the more important in that it is so easily remediable. Ground glass bulbs and proper position of the lights will do away with all the bad effects. As yet laymen do not appreciate the importance nor understand the principles of this subject. In officers' rooms, which are furnished with portable lights, it is rare to see the lights placed properly. This subject of the location of the lights in the living spaces of a ship, being of so much hygienic importance, should be determined by a board of medical officers."

THE ELECTRIC RAILWAY.

WARREN, OHIO.—The Cleveland & Chagrin Falls Electric Railway Company has bonded its line for $300,000, and will build an extension to Warren at once.

HARRISBURG, PA.—A charter was granted to the Allentown & Slatington Electric Street Railway, which is to be operated between those two points with 17 miles of track. The capital stock of the corporation is to be $200,000.

WASHINGTON, D. C.—The large, barn-like car-shed of the Eckington & Soldiers' Home Railroad Company, at the corner of Fourth and T Streets, northeast, was totally destroyed by fire. About thirty cars were destroyed in the fire. The total loss is estimated at $65,000.

BALTIMORE, MD.—It is stated that the controlling interest in the Baltimore City Passenger Railway Company has been secured by the Baltimore & Northern road. The latter was a suburban feeder for the City Passenger Railway. It is stated that the price paid per share was $90.

NEW YORK, N. Y.—The Union Railway Company has started to run cars between One Hundred and Twenty-ninth Street and Third Avenue and Yonkers, on which passengers are only charged a fare of 5 cents. The company declares that this is the longest ride to be had in the country for a 5-cent fare, the distance being 14 miles.

NEW YORK.—The stockholders of the Metropolitan Street Railway Company, of this city, at their meeting last week, re-elected the old board of directors, as follows: H. H. Vreeland, W. L. Elkins, Thomas F. Ryan, Charles E. Warren, Henry P. Whitney, P. A. B. Widener, Thomas Dolan, D. B. Hasbrouck, and H. A. Robinson.

NEW YORK, N. Y.—Deputy Commissioner Quinn of the Department of Street Cleaning has been trying to get the surface railroad companies in Brooklyn to pay their share of the expense in clearing snow from the thoroughfares in which trolley cars operated. He has failed to secure the co-operation of the companies, and has now placed the matter in the hands of Assistant Corporation Counsel Chittenden, who will bring an action against each of the companies to compel them to pay part of the expense in clearing the snow from the streets, as is required by an ordinance adopted by the Common Council in Brooklyn in December, 1895.

NEW YORK, N. Y.—Before the Municipal Assembly, on December 22, residents of New York city north of the Harlem River will oppose the unconditional extension of the Third Avenue and Metropolitan Railway Companies' lines into the Bronx. These residents wish to exact from the corporations named an agreement to carry passengers from one end of their lines to the other for 5 cents each, and to construct all proposed lines within a reasonable time, not exceeding two years. They are opposed to granting any more franchises unless such an ironclad agreement is incorporated in the concession and a guarantee given that the contract will be faithfully carried out.

NEW YORK.—The Metropolitan Traction Company has begun to operate its Sixth and Ninth Avenue lines as far south as Canal Street. Electric cars will be run to the terminal at Canal Street and Broadway, and transfers will be given at that point to the Broadway cars. A date has been set for the change in motive power on the Broadway line. It is now said that June 30 will see the electric cars in use there. It was at first thought that the line would have to cease operations for several days while the change is being made. The engineers have overcome this by a device in the construction of the conductor bars, so that the cable and electric power can be operated at the same time. In this way the change will be a gradual one, and will embarrass neither the company nor its patrons.

TAUNTON, MASS.—At a meeting of the directors of the Taunton Street Railway Company, H. Frank Bassett was chosen president, George A. Washburn treasurer, and Fred S. Hall attorney. The company is contemplating putting in storage batteries in its power station in this city, not because the power at present is overtaxed, but in the interest of economy. At present the two engines run in such a manner that much power is wasted. The engines in that period will probably run ten or fifteen minutes and will do nothing for the rest of the hour. When the storage batteries are put in it will be possible to discontinue running one of the engines, while the other will then have enough work to keep it running all the time. The storage battery will furnish the rest of the power needed.

WILMINGTON, DEL.—About January 1 the Wilmington and Chester Traction Company expects to open its through line between Wilmington and Philadelphia. This company, which acquired control of the street railway systems of Chester and Wilmington a year or more ago, has reconstructed a portion of the lines in both cities, and put the systems in good physical condition. The link connecting Chester and Wilmington is almost completed. The time between Fourth and Market Streets, this city, and Broad and Chestnut Streets, Philadelphia, will be about two and one-half hours, more than twice as long as the time trains on the Pennsylvania and Baltimore and Ohio Railroads require to make the trip between the stations in the two cities. The fare will probably be 30 cents for the single trip, which includes the fare on the Union Traction cars from Darby into Philadelphia, and 3 cents more if it is necessary to get an exchange. This will be 60 cents for a round trip. The fare on the steam roads for a round trip is $1.

HARRISBURG, PA.—Reports received at the Department of Internal Affairs show that ninety-four street railway corporations, with a total capital stock outstanding of $100,909,335, are operating in Pennsylvania. Of this amount about $24,500,000 is issued by the Traction Company of Allegheny county. In addition to the amount of stock of lesser companies there is $56,027,922 of corporations whose lines are operated by lesser companies. The total stock capitalization of street railway corporations in the State is $156,937,257. The bonded indebtedness of operating street railway companies is $32,440,850, and the current liabilities are $14,229,491. The funded and unfunded debt of non-operating railways is $40,810,690, showing a total of bonded and floating debt of $87,481,031. The total capitalization, including bonds and floating indebtedness, is $244,418,288. The total operating expenses of street railway companies of the past year were $9,486,573. In addition there was paid $1,211,135 in taxes, $2,250,797 interest on funded debt, $6,089,871 rentals, $256,367 other expenses and $804,169 dividends, or a total of $20,096,912. This aggregate does not include any disbursements of lesser corporations. The total mileage of street railway tracks is reported at 1,422.84, and the aggregate length of tracks operated at 1,708.32. The number of cars owned is 6,616; number of employes, 12,680; total compensation of employes, $6,542,840, and number of passengers carried, 432,779,314. The total number of passengers killed during the year was fifteen, and the number injured 506. The total number of passengers, employees and others killed was 106, and injured, 1,101. The Secretary of Internal Affairs condemns the methods of capitalizing street railways by some companies. He also calls attention to the consolidation and merger of some companies without sanction of law. He suggests that additional legislation providing for better supervision of street railways should be passed in order to prevent capitalization at three or four times the probable cost of the road.

EDUCATIONAL NOTE.

THE ANNOUNCEMENT of the college of engineering of the West Virginia University, Morgantown, W. Va., gives complete information regarding the course of instruction at this university. The instruction in electrical engineering possesses some unique features. It is conducted on the four-quarter system by which students may prosecute their work uninterruptedly and to equal advantage in summer and winter. Another feature is the two-year electrical certificate course for those students who want to have a thorough grounding in elementary theory and practice of electrical engineering work, without being required to meet all the conditions for admission and graduation of the regular four-year courses. The fourth or senior year in the regular four-year mechanical engineering course is made elective, the students having the option of taking either the electrical or mechanical alternative that year. There are also elective electrical engineering studies for students pursuing scientific branches in the regular four-year courses in the university. The only preparation necessary for the two-year electrical certificate course is in those branches of English, physics and mathematics necessary to intelligently pursue the course. This brings it within the reach of many young men engaged in daily work who have not had the advantages of high school or college training. Students who enter these courses are not obliged to lose the summer vacation between sessions, but may carry on their work at the university during the summer quarter as at any other time in the college year. Under this new system of university organization students may enter upon their work on January 1 next or at the beginning of any other quarter.

Legal Notes.

THE SERIES PARALLEL CONTROLLER CASE.—The preliminary injunction ordering the Nassau Electric Railroad Company, of Brooklyn, to cease using four types of railway controllers manufactured by the Steel Motor Company (see The Electrical World, September 3, page 251) has been sustained on appeal to the Circuit Court of Appeals, by Judge Shipman, the text of the opinion having been filed December 7.

CONTRACT BY TELEPHONE.—In reply to an inquiry the "New York Journal of Commerce and Commercial Bulletin" prints some facts based on legal decisions concerning bargains made by telephone, which are of sufficient general interest to justify their republication in this department. "A contract for the sale of goods made over a telephone," it states, "stands upon the same footing as a verbal contract made without the intervention of the telephone. No part of the purchase price being paid, and no part of the goods delivered, the contract is not enforceable if the price of the goods sold is $50 or more; if the price is less than $50 the contract is as valid as if it were written. The statute of frauds of this (New York) State provides, in case where there is no delivery and no payment or part payment, that every contract for the sale of any goods * * * for the price of $50 or more, shall be void unless a note or memorandum of such contract be made in writing and be subscribed by the parties to be charged thereby."

Trade and Industrial Notes.

MESSRS. HUEBEL & MANGER, Brooklyn, N. Y., are carrying a large assortment of standard cast-bronze push buttons in oxidized copper finish, and report that they are selling a great many of them.

THE SIOUX CORLISS ENGINE at the Omaha Exposition has been awarded the gold medal. This engine was built by the Murray Iron Works Company, of Burlington, Ia., and it was in continuous operation, twenty-four hours per day, during the greater part of the Exposition.

ENGINEER'S POCKET DIARY.—The "Mechanical World," which is published in Manchester, England, has issued a Pocket Diary and Year Book for 1899. It is substantially bound in cloth, and contains a collection of useful engineering notes, rules, tables and data. The diary feature gives space for every day in the year.

"LIGHT" is the title of a little pamphlet issued by the Westinghouse Electric & Manufacturing Company, on the subject of arc lamps of the long-burning type. The Westinghouse Company is manufacturing long-burning arc lamps for both direct and alternating current. The direct-current lamps are designed for 110, 220 and 500 volt circuits. Those for alternating-current work are said to be noiseless and to give a steady light.

MEDAL FOR TELEPHONE APPARATUS.—The Pennsylvania Electric Company, of Marietta, Pa., announces that it has received the highest award—a medal—from the Trans-Mississippi and International Exposition at Omaha on its telephone apparatus. The company is naturally elated over its good fortune. It is busy just now filling an order from the Independent Telephone Company of Lancaster County, Pa., for 2000 telephones.

THE LA ROCHE CIRCUIT BREAKER.—The circuit breaker manufactured by Messrs. F. A. La Roche & Co., New York, is the subject of patent No. 615,395, issued December 6, to Mr. F. A. La Roche. This breaker, which is now quite well known, embodies two knife switches running in vertical slides with following carbon breaks, their latches controlled by two triggers, both struck by the armature of the solenoid between them.

PHOSPHOR-BRONZE CASTINGS.—The Standard Brass Works, Kalamazoo, Mich., are making a specialty of phosphor-bronze castings for manufacturers of dynamos, motors and engines, both steam and gasoline. The works desire to make contracts with manufacturing firms who want any kind of cast brass, bronze, copper, etc. They will undertake special work for manufacturers. Those concerns who have no brass foundry of their own will do well to communicate with the Standard Brass Works.

PARTRIDGE SELF-LUBRICATING MOTOR BRUSHES, like all meritorious goods, continue to grow in favor and use. This make of brush is one of the earliest in the field. It was a first-class brush at the start and has maintained that reputation ever since. The Partridge Carbon Company, of Sandusky, Ohio, has been making these brushes for a good many years, and the fact that a majority of electric railways are using them may be very reasonably accepted as an indication that they are giving satisfaction.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has taken the general Western agency for the Crescent tin shade. This shade has been designed with a view to displacing the ordinary flat tin shade, and is being manufactured in large quantities and sold at less price than the flat shade. It is curved in shape to concentrate the light as much as possible, and has its bright surface corrugated to give a good distribution. It should certainly find a large field where the demand is for a durable and inexpensive shade or reflector.

MR. HENRY G. ISSERTEL, formerly in the Boston office of the Walker Company, has been appointed as its manager for the Middle Atlantic States by the Anchor Electric Company, of Boston. Mr. Issertel will have headquarters in the Havemeyer Building, New York City. Mr. Issertel will be glad to see his old friends at the Anchor Company's office. He will carry a small stock of the company's products for emergency orders and do everything needful for the convenience of the company's customers in New York and vicinity.

VITOGEN is a powder dressing for burns, scalds, wounds, etc., and is an antiseptic. It is a valuable article to have on hand in electric light and electric power stations where the attendants are liable to receive accidental burns and hurts. Much suffering may thus be avoided and healthy conditions promoted in such emergencies. No pain, odor or irritation arises from the use of this powder. The G. F. Harvey Company, Saratoga Springs, N. Y., manufactures this article, which has the endorsement of many physicians throughout the country.

THE BALL ENGINE COMPANY, Erie, Pa., reports that the New York Trade School has recently placed in operation two 70-hp engines of its make, each being direct connected to a Siemens & Halske generator. It also reports that the electric plant at St. Agnes' Hospital, Philadelphia, which is equipped with two Ball engines, direct connected to Eddy dynamos, is now in operation. The Billings Water Power Company, Billings, Mont., has recently placed in operation a 150-hp tandem compound engine of the Ball Engine Company's make.

STANLEY INDUCTION MOTORS.—The Western Electric Company, Chicago, for the purpose of promptly filling orders, now carries a complete stock of Stanley induction single-phase and two-phase motors. The former are made only in two sizes, viz., one-fourth and one-half horse-power, for either 50 or 100 volts and for 8000 to 16,000 alternations. The two-phase motors (for either 8000 or 16,000) range in sizes from 1 to 40 horse-power. A complete stock of motor transformers is also carried. Full description and prices will be sent to those who are interested.

THE SAFETY THIRD-RAIL ELECTRIC COMPANY has just issued a pamphlet very completely describing and illustrating the Murphy sectional-conductor system. The difficulties encountered in many of the earlier systems of this class and how they are overcome in the Murphy system are pointed out. The various systems referred to are illustrated, thus enabling a better comparison between them and the Murphy system. Some important improvements have been made in the details of the Murphy system, the principal features and the operation of which were described and illustrated in The Electrical World of January 29, 1898.

MR. D. W. PHELAN, 280 Broadway, New York, dealer in ties and poles, reports a very successful year. The use of octagonal yellow pine poles appears to be increasing. Mr. Phelan furnishes these direct from his own mills in the South, either painted or treated with a creosote preparation which doubles the life of the pole, while adding only a trifle to the cost. He has handled many of the largest contracts that have been placed the past year, and looks forward to an increase of business in 1899. In addition to the above Mr. Phelan represents the Michigan Pipe Company in New York and vicinity for the sale of its creosoted wood conduit.

MESSRS. MACHADO & ROLLER, 203 Broadway, New York, state that their business is showing a marked and very steady increase in volume. Their new dead-beat Whitney portable and switchboard instruments are being used and specified by a large number of the most prominent consulting engineers in the city, and reports of very flattering character on the performance of their A. E. G. lamps are being received almost daily. A large stock of both is carried by the firm so that their clients' orders may receive prompt attention. They are always glad to have their friends call to see them and inspect the various new appliances that they bring out from time to time.

THE D. M. STEWARD MANUFACTURING COMPANY, Chattanooga, Tenn., has every reason to be satisfied with existing trade conditions. It reports that the volume of its business is now greater than ever before, and that it has of necessity been running its factory night and day for a long time. This refers to all departments of the company's work, but especially to the lava insulator department. The lava electric insulators manufactured by this company have a high reputation for quality and serviceability. In a recent competitive test between this company's Special Union Jet Burner and a well-known burner of English make the result was decidedly favorable to the American burner.

MONTAUK MULTIPHASE CABLE has received the careful consideration of the Boston Fire Department, which has made an official investigation into the merits of this type of cable. The report of Mr. B. S. Flanders, superintendent of the fire alarm, Boston, the gentleman who conducted the experimental investigation, states that the cable appeared to him to be a valuable adjunct for use in any automatic fire-alarm service dependent on the action of thermostatic devices for its operation. He based his opinion on the fact that the cable is so constructed as to be thermostatic throughout its entire length. He believes that this cable is superior to the isolated thermostats used in the present automatic systems.

THE ERIE GAS ENGINE COMPANY, Erie, Pa., has just finished the building of a two-cylinder 200-hp gas engine for the McCoy Plate Glass Company, of Kane, Pa. This engine was recently shown in operation at the Erie company's works, and was developing its rated horse-power on a consumption of 10 cubic feet of natural gas per horse-power hour. The company is doing a large business in the manufacture of gas engines, and has several orders in hand now being filled for delivery to various parts of the country. One of these includes a 100-hp engine to go to the Empire Mills at Olean, N. Y. It is stated that the difficulties of starting large gas engines have been satisfactorily overcome by the Erie company.

A WEATHERPROOF BELL.—Messrs. Edwards & Co., 144th Street and Fourth Avenue, New York, have produced a bell which is designed for use in exposed places, such as mines, railroad stations, factories, etc. It is the invention of Mr. Lungen, of the firm, and is claimed to meet all the requirements of a bell for use under such conditions. The motion of the hammer is direct and unlike any other, and does not work on a pivot. It is made either single stroke or vibrating, and its vibrations are so rapid that when used to give signals they are more positive than when given by single strokes. The case has no crevices to admit dampness or dust, and the hammer is adjusted from the outside of the case by a screw. The bell will work in any position, and is designed to operate on any voltage.

DIE-MAKING has become such an important industry in the mechanical world that the subject has received the dignity of special consideration in the form of a book entitled "Dies and Die-Making," and published by Messrs. J. L. Lucas & Co., 92 Westfield Street, Providence, R. I. The author, Mr. J. L. Lucas, in the preface, states that it is a shop book, written by a shopman and intended for shop use. It is therefore a practical work on a most practical and important subject. It is very profusely illustrated with dies and punches for all kinds of work, including the manufacture of armature discs. A good deal of information is given about the various machines, and the work will no doubt be of special value to machinists. It is the first publication of its kind, and contains 100 pages, substantially bound in cloth.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., calls attention to the fact that its improved induction sewing-machine motor makes a useful and acceptable Christmas present in any household. These motors are particularly adapted for use by inexperienced persons, and the entire device is easily attached to any make of family sewing machine. By a slight movement of the sewing-machine treadle the motor may be started, stopped or the speed regulated. This motor is said to be thoroughly practicable, and is fully guaranteed to give perfect satisfaction in every way. In order to fill orders promptly, however, it is necessary when ordering to state the voltage and alternations of the current to be used, the direction in which the hand wheel of the sewing machine revolves and the style of plug and socket.

THE INTERNATIONAL ELECTRIC COMPANY, 76 Beekman Street, New York, has been busy during the past year in the manufacture of large coils for X-ray apparatus. It has been carrying on considerable work in the construction of apparatus for the production of ozone for use in the purification of liquids and the preservation of solids. The company states that this work is of great consequence, and claims that it will open up new lines for thought and business possibilities. The company is constantly called upon to work out theoretically as well as practically many knotty problems in the experimental line, some of which having merit may be heard from sooner or later. The International Electric Company does a great variety of work, such as conducting experiments, designing, manufacture of small machinery, motors, fans, cigar lighters, milling machine work, etc., etc., and has added some new machinery in order to better handle its business, which is constantly growing. It reports that it will soon be necessary to secure larger quarters.

LIGHTING SHOW WINDOWS.—At this time, when the streets are thronged with holiday crowds, it is interesting and instructive to note the difference in effect between store windows lighted at night in the ordinary way with incandescent lights in full view and those lighted by the Frink store window reflector, where no lamps show, but where there is an abundance of light. The comparison is unquestionably favorable to the Frink system, for exposed incandescents, by their greater brilliancy, distract the eye from the goods displayed, and often make it impossible to see the goods effectively. In order that an object may be seen with the least strain upon the eyes, the source of light should be behind the person, and this is the cardinal principle of the Frink system. It consists of a hood-shaped reflector running along the side of the glass at the top of the window. Inside the reflector the incandescent lamps are placed. The shape of the reflector shields the lamps from outside view and reflects all the light within the windows. Full information regarding this method of lighting windows may be obtained by addressing I. P. Frink, 551 Pearl Street, New York.

QUICK WORK IN FURNISHING BELTS.—A remarkably quick piece of work was recently accomplished by Messrs. Charles A. Schieren & Co., belt manufacturers, New York City. On December 1 a steam pipe burst in the station of the Virginia Electric Light Company at Norfolk, Va., and the escaping steam ruined the belts. Mr. Peter Wright, the superintendent of the station, at 10 o'clock on the morning of December 2, telephoned to Messrs. C. A. Schieren & Co. that he wanted 77 feet 8 inches of 36-inch three-ply leather belt, 120 feet of 10-inch double leather belt, 220 feet 12-inch leather belt, and 120 feet 17-inch double belt, stating that he must have it all immediately. All of the belts were shipped by express on the same afternoon, and that night a man was sent down from New York to put them in. On the night of December 3 all the belts had been placed and were in running order. Messrs. Schieren & Co. have recently fitted up the new municipal electric light station at Madison, N. J., with a complete equipment of belts, including one 48-inch, one 42-inch, two 18-inch and one 13-inch double belts and numerous single belts. The firm is doing a large business with Cuba, Australia and Hawaii, and its export trade is rapidly increasing.

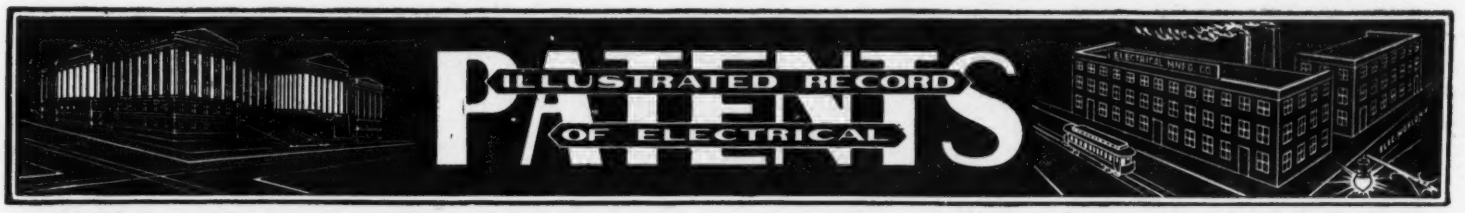
CABLE TESTING APPARATUS.—Mr. James G. Biddle, 910 Drexel Building, Philadelphia, has recently issued a new catalogue of electrical measuring instruments, in which are described apparatus for testing resistance, insulation and capacity of aerial, underground and submarine cables. Portable outfits, as well as equipments for station use, are carefully described and should be very interesting to all who have occasion to make measurements. Mr. Biddle's experience in this line of business covers ten years or more. Among his recent customers for cable-testing equipment may be mentioned the following: The Union Traction Company, Central District & Printing Telegraph Company, Hartford Electric Light Company, St. Anthony Falls Water Power Company, Postal Telegraph Cable Company, Valley Telephone Company, Safety Insulated Wire & Cable Company, Borough of Manhattan Electric Company, Washburn & Moen Manufacturing Company, Central Union Telephone Company, District Engineer, Washington, D. C.; Tucker Electrical Construction Company, St. Louis Electric Construction Company, New York Telephone Company, Cataract Power & Conduit Company, War Department United States Government, San Francisco Fire Alarm & District Telegraph, Delaware & Atlantic Telegraph & Telephone Company, etc., etc.

THE WESTINGHOUSE MACHINE COMPANY, Pittsburg, Pa., has just issued a 96-page pamphlet on its compound engine, which is unique in the line of catalogue work. It gives a description in detail of the construction of the Westinghouse engine, and makes extremely interesting reading. The pamphlet makes the following interesting observation on the subject of direct connection with dynamos and generators: "The company believes that from an engineering standpoint the spring-coupled outfit furnishes the best solution of the problem. The question of perfect alignment of bearings is eliminated, contributing to cool running and making the effect of unequal wear in engine bearings and dynamo bearings negligible. The cushioning effect of the spring transmission in absorbing shocks due to sudden changes of load or to accidental short circuits must of necessity be beneficial both to engine and generator. There exists, however, partially on account of greater compactness, partially because of the difference in cost between a complete dynamo and a simple armature and field frame without shaft or bearings, and partially on account of individual preference, for which it would be difficult to assign a reason, a demand for a construction involving the extension of the engine shaft carrying the armature and supported by a single bearing at the outer end." The pamphlet is very completely and artistically illustrated, many of the cuts showing the details of the engine. Very rarely, indeed, is a subject so thoroughly covered in trade literature as has been done in this case, and the reading matter in connection with the illustrations cannot fail to give to those entirely unfamiliar with the engine a very thorough comprehension of its construction and operation.

Business Notices.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 9-15 Murray Street, New York City.

AN UNPARALLELED TIME RECORD was made every day during the period of the Omaha Exposition by the trains of the Chicago, Milwaukee & St. Paul Railway on its Chicago & Omaha Short Line. Although its trains hauled from ten to thirteen well-filled sleeping cars and coaches each night, yet schedule time of arrival at Omaha and at Chicago was an accomplished fact—a record to be proud of, and which has resulted in establishing the Chicago, Milwaukee & St. Paul Railway in the minds of the traveling community as the shortest, best and most reliable route from Chicago to Omaha, as well as to California. All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway. For information regarding the line address William Kelly, Jr., General Eastern Passenger Agent, 381 Broadway, New York.



UNITED STATES PATENTS ISSUED DECEMBER 6, 1898.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

615,209. ELECTRICAL HINGE CONTACT; C. Baxter, of New York, N. Y. App. filed Nov. 21, 1895. In an electrical connection for hinges, the combination with one flap of a hinge, of a spring contact located thereunder and having a portion thereof curved over the roll of said flap, and a contact located under the other flap and in rubbing engagement with the curved portion of the spring contact. (This patent was issued November 29, 1898.)

615,419. RHEOSTAT; Charles Wirt, of Philadelphia, Pa. App. filed July 26, 1897. In a rheostat, the combination with a casing, of a continuous electrical conductor folded within said casing, fixed contact pieces intermediate of said folds, a movable contact member mounted upon said casing, and means to shift said member in direct contact with the successive folds of said conductor.

615,246. ELECTRIC BATTERY; O. T. Bugg, Jr., of New York, N. Y. App. filed March 15, 1898. An electrical battery having a containing vessel of conducting material, in combination with a perforated interior cylinder also of conducting material, and a mass of active material, such as flaky lead, packed between the inner wall of said vessel and the cylinder, together with a zinc electrode rigidly secured to the cover of the vessel, which latter is constructed of insulating material, substantially as described.

615,265. ALTERNATING-CURRENT DYNAMO-ELECTRIC MACHINE; S. Ziani de Ferranti, of Hollinwood, England. App. filed Dec. 28, 1897. In an alternating-current dynamo-electric machine having a disc armature, the combination with the bobbins composing the armature, of separately insulated supports for said bobbins, and means for adjusting the armature radially and compressing the sections after the machine has been in use.

615,292. ELECTRIC BATTERY; M. Maas, of New York, N. Y. App. filed Sept. 7, 1897. In an electric battery, the combination of a zinc, a hollow carbon provided with a longitudinal recess, a binding post provided with a shank fitting said recess and with an opening in that end, a binding wire passing around the carbon and through said opening in the shank, and a copper-plating covering the upper part of the said carbon, binding-post and binding-wire, substantially as described.

615,244. TELEPHONE; F. Burger and H. M. Williams, of Fort Wayne, Ind. App. filed Aug. 16, 1897. A telephone apparatus, comprising a bar, a slidable handle mounted on the bar, contacts controlled by said slidable handle, and a crosspiece supporting the telephone instruments, substantially as described.

615,347. ELECTRIC SWITCH; W. Ely, of Providence, R. I. App. filed Aug. 14, 1896. In an electric switch having a rotatable shaft and a crank or crank arm rigidly secured thereon, and supporting means, combined with said parts, an arm open-slotted at one side and rotatably fitted upon said shaft and crank concentrically therewith and capable of partial rotation without reference to the movements of the same, a pivoted guideway adapted for oscillating movement, a crosshead adapted for reciprocating

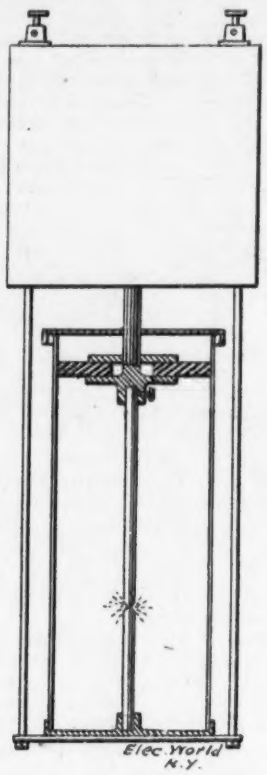
movement in said guideway and for oscillating movement therewith, and pivotally connected with the free end of said arm, and an extensible spring connecting said crosshead and the free end of said rigid crank or crank arm.

615,349. ELECTRIC CABLE CONDUCTOR; S. D. Field, of Stockbridge, Mass. App. filed Dec. 24, 1897. A cable conductor composed of the insulated wire or wires of an electrical circuit, and one or more iron companion wires or rods not included in such circuit, the said insulated wires and iron wires being interbraided or interlaced.

615,351. DYNAMO-ELECTRIC MACHINE; J. E. Fuller, of New York, N. Y. App. filed March 24, 1898. The combination with the field magnet, of an armature having a core and coil and an external circuit to a lamp, a governor at one end of the armature, and a spring to draw back the governor, such governor acting to lessen the magnetism in the armature when in contact with poles thereof.

615,365. ELECTRICAL APPLIANCE FOR ELEVATORS; J. H. Roberts, of Grand Rapids, Mich. App. filed Dec. 27, 1895. In electrical apparatus, the shafts, the arms and adjustably secured thereon, and the contacts on said arms, combined with the contacts for said contacts, and means for actuating said arms from the hoisting mechanism.

615,388. APPARATUS FOR OPERATING ELECTRIC SWITCHES; C. Hartdegen, of Newark, N. J. App. filed July 30, 1897. The combination with an electric switch, of a timepiece, its train of gear mechanism, its



No. 615,408.—ELECTRIC ARC LAMP.

winding arbor and a helix on said arbor, and means connected with said switch in engagement with said helix for automatically actuating the switch mechanism and closing the same, substantially as described.

615,407. ELECTRIC ARC LAMP; M. S. Okun, of New York, N. Y. App. filed June 3, 1895. In an arc lamp, a carbon operating rod or carrier, a carbon holder, an intermediate rod, and ball-and-socket joints at the ends of the intermediate rod connecting said carbon operating rod or carrier with said carbon holder, and means for guiding a carbon when carried by said holder.

615,408. ELECTRIC ARC LAMP; M. S. Okun, of New York, N. Y. App. filed Oct. 21, 1895. In an arc lamp, a globe closed below the arc, and a disc or plate fitting snugly within said globe so as to travel up and down therein with the upper carbon to retard the access of air to the arc.

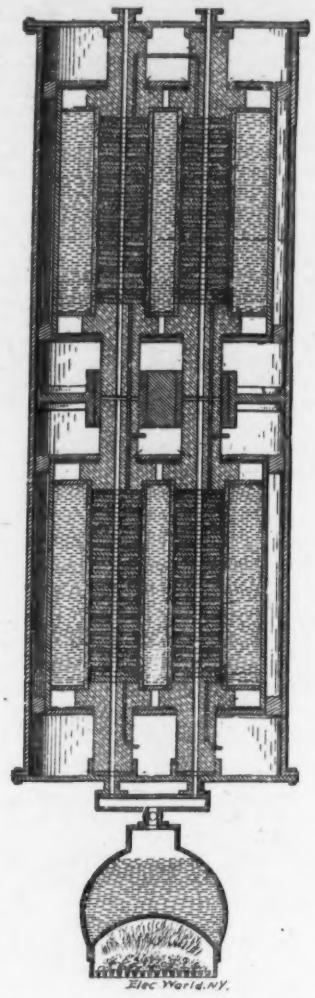
615,420. ELECTRICAL CONNECTION; W. E. Baker, of Chicago, Ill. App. filed July 13, 1896. In an electrical connection for railway cars, the combination with adjacent cars of a train, of a box mounted on the adjacent end of each car, a casting mounted therein, provided with a pair of contact-making devices, a link provided with co-operating contact making devices at each end thereof, one of said contact devices comprising a cylindrical sleeve forming a socket, and the other comprising a plug adapted to be received in the sleeve when in use.

615,455. BINDING POST; J. P. Jones, of Webster, Pa. App. filed May 7, 1898. In a binding post, a body portion having a bearing plate with an opening formed therein, a socket having a plate with a stud extending therefrom adapted to enter said opening, a nut on said stud and a spring interposed between said nut and bearing plate, substantially as described.

615,471. REFLECTOR; A. E. Boeschenstein, of St. Louis, Mo. App. filed Feb. 28, 1898. The combination with a bracket, of lamp supports mounted in said brackets, and lamps having corrugated terminals at opposite ends which co-operate with said lamp supports, substantially as described.

615,539. ELECTRIC BATTERY; P. A. Emanuel, of Aiken, S. C. App. filed May 17, 1898. A porous diaphragm for electric battery cells having enlargements upon each face thereof, said enlargements being impervious to the passage of fluids, substantially as described.

615,540. ELECTRIC BATTERY; P. A. Emanuel, of Aiken, S. C. App. filed May 17, 1898. The combination with a vessel, of a plurality of porous tubes passing through the said vessel, a voltaic pile carried within each of



No. 615 541.—ELECTRIC BATTERY.

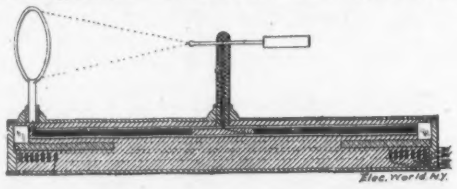
said tubes, and an electrolyte carried by said vessel and surrounding said tubes, substantially as described.

615,541. ELECTRIC BATTERY; P. A. Emanuel, of Aiken, S. C. App. filed May 17, 1898. A thermo-electric pile, which consists of a plurality of thermo-electric couples separated from each other by porous diaphragms and inclosed in a porous casing, substantially as described.

615,584. BLOCK-SIGNAL SYSTEM; W. L. Stockton, of Trenton, Ohio. App. filed Dec. 20, 1897. In an electric block-signal system, a feed wire, a trolley wire having shunt connection with the feed wire, switch trolley wires at the ends of the trolley wire, but insulated therefrom, a wire connecting the switch wires, a shunt between said connecting wire and the feed wire, an electromagnet in each of the shunts, a signal circuit, and a switch operated by the electromagnets for cutting in and out a connection between the feed wire and signal circuit, substantially as described.

615,652. HIGH-FREQUENCY APPARATUS; T. B. Kinraide, of Boston, Mass. App. filed May 13, 1897. In an induction device, a primary having end portions of low resistance and extended area, said portions consisting of ribbon-like flat coils, substantially as described.

615,653. HIGH-FREQUENCY INDUCTION APPARATUS; T. B. Kinraide,



No. 615,653.—HIGH-FREQUENCY INDUCTION APPARATUS.

of Boston, Mass. App. filed March 4, 1898. An induction apparatus, comprising an electric conductor whose resistance per turn diminishes as its voltage increases, and an exciting field winding adjacent and confined to the low voltage portion of said conductor, substantially as described.

615,665. SWITCH CONTACT; M. Guett, of Hartford, Conn. App. filed May 23, 1898. In a device, a spring doubled on itself into a plurality of arms, One arm having an opening therein, and a connection between the sides of said arm adapted for attachment to a support.